POWER PLANT ENGINEERING

GENERATION, TRANSMISSION AND UTILIZATION OF STEAM, ELECTRIC, DIESEL AND HYDRAULIC POWER

Contents

Cover

One of the two 650 lb. pressure, 6000-kw. generating units in the new "top" plant at the Rochester Gas & Electric Co. at Rochester, N. Y.

Power Development in 1937 710
The World Turned Upside Down 712
Washington Ruling Limits Coulumbs Law 715
Balancing the B.T.U. and the Dollar 718
Steam on the Up and Up 723
Round and Round She Goes 727
Electric Generators Take Gas 730
Government Projects Boost Hydroelectric Capacity 732
New Charleston Paper Mill Operates at 600 lb. 700 deg. F 734
Modern Turbines. By L. E. Newman 741
Indicating High Speed Diesels. Part III. By E. T. Vincent 746
Lets Look at Efficiency. By David Hall 748
Prevention of Clinker in the Industrial Stoker. By J. R. Darnell 752
Unit Heater Standardization 754
Steel Mill Increasing Power Facilities 755
Sleeve-Poppet-Valve Uniflow Engine 757
Readers' Conference 759
Coal Producers and Users Meet 763
New Equipment 765
News from the Field 769
For The Engineer's Library 772
New Engineering Books 774
Power Plant Construction News 776

Contents of back issues of Power Plant Engineering will be found in Industrial Arts Index on file in Public Libraries.

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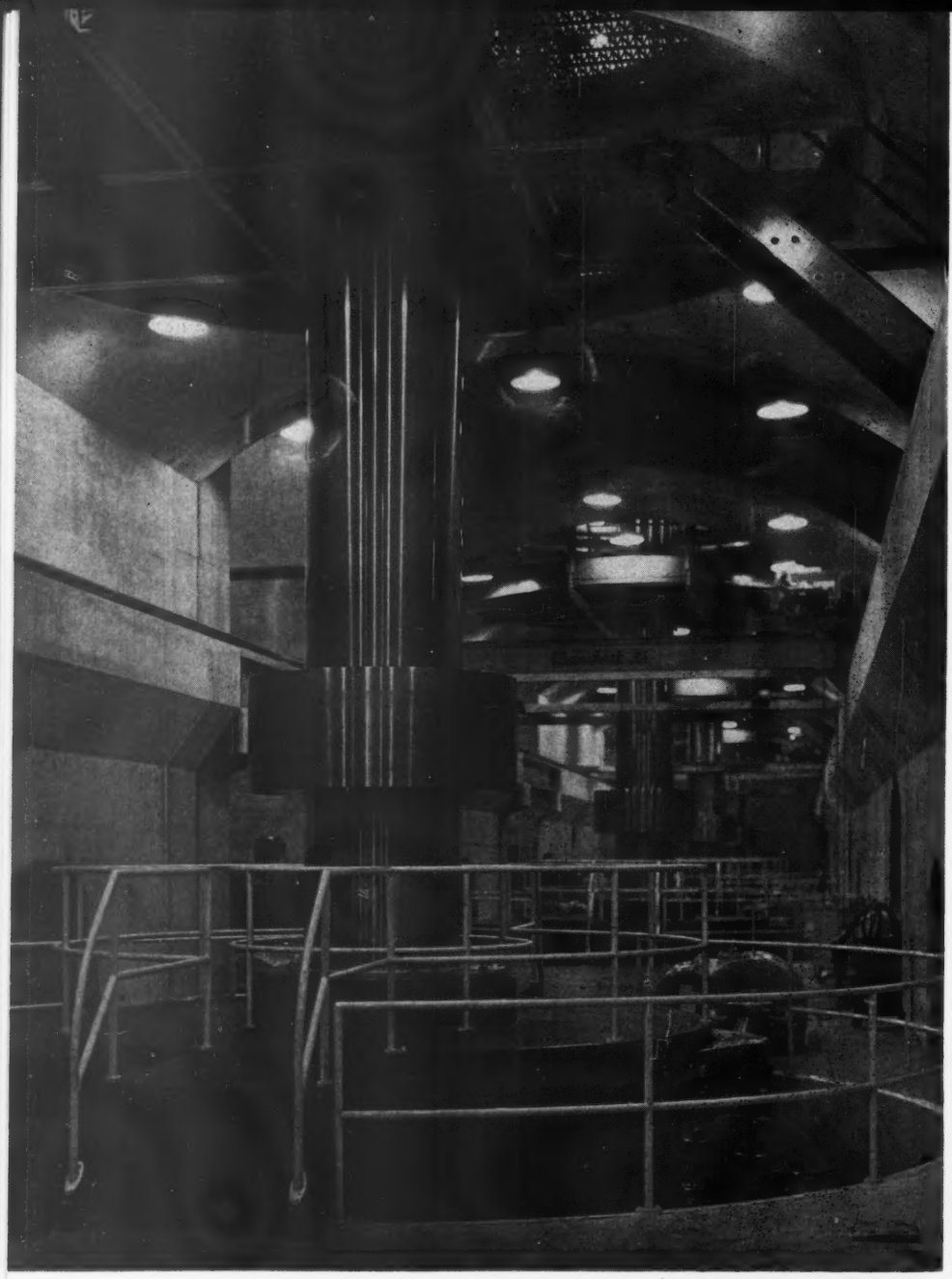
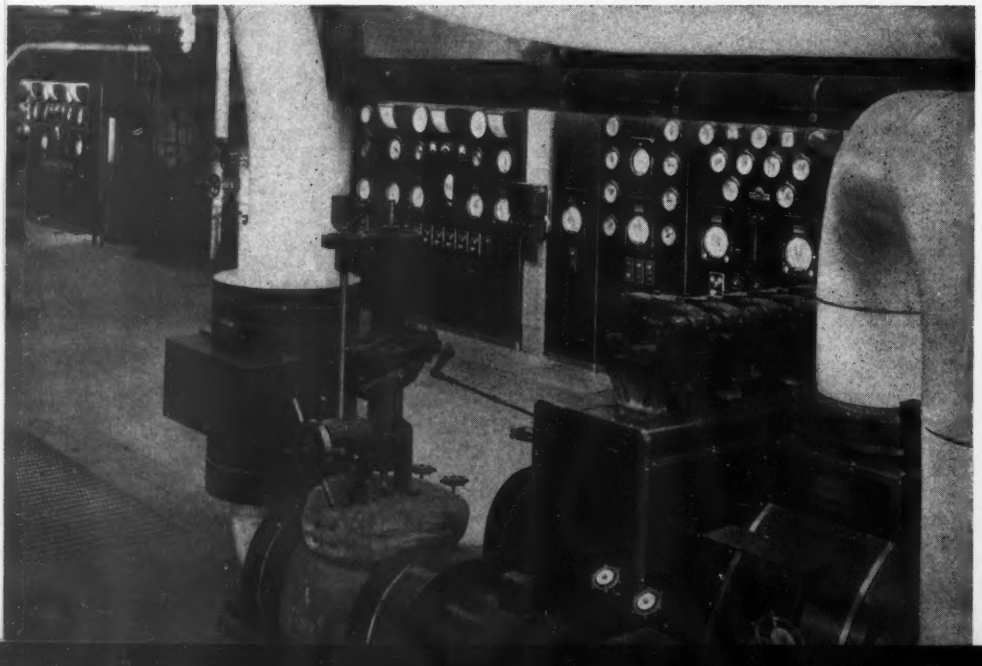


Upper Left: The turbine gallery in the Nevada wing at Boulder Dam power house. The scroll cases are embedded in concrete below the gallery floor. The drive shafts, 38 inches in diameter, connect the 115,000 hp. turbines directly with the 82,500 kv-a. generators on the floor above. (Photo, Bureau of Reclamation)

Lower Left: A view in the turbine room at the new "top" plant of the Rochester Gas & Electric Co. showing one of the two 6000 kw. turbines in the foreground.

Lower Right: The steel industry is one of the large users of power. Single turbines of 25,000 kw. are installed in some steel plants. This particular view is that of the Gary Works at the Carnegie Illinois Steel Corporation. (Photo by Fred C. Korth)



R DEVELOPMENT IN 1937

ONCE again the time has come to present a review of the year's developments in the power industry. In the pages that follow we have endeavored, to the best of our ability in the limited space available, to give you a picture and to a certain extent an interpretation of conditions and practices as we see them. Like any other thing born of human effort, it has its shortcomings. Many things which might have received attention no doubt have been left out; other things of less importance may seem to have been given too much attention. Such shortcomings will appear differently according to the varying interests of the readers. In any case we probably will hear about them.

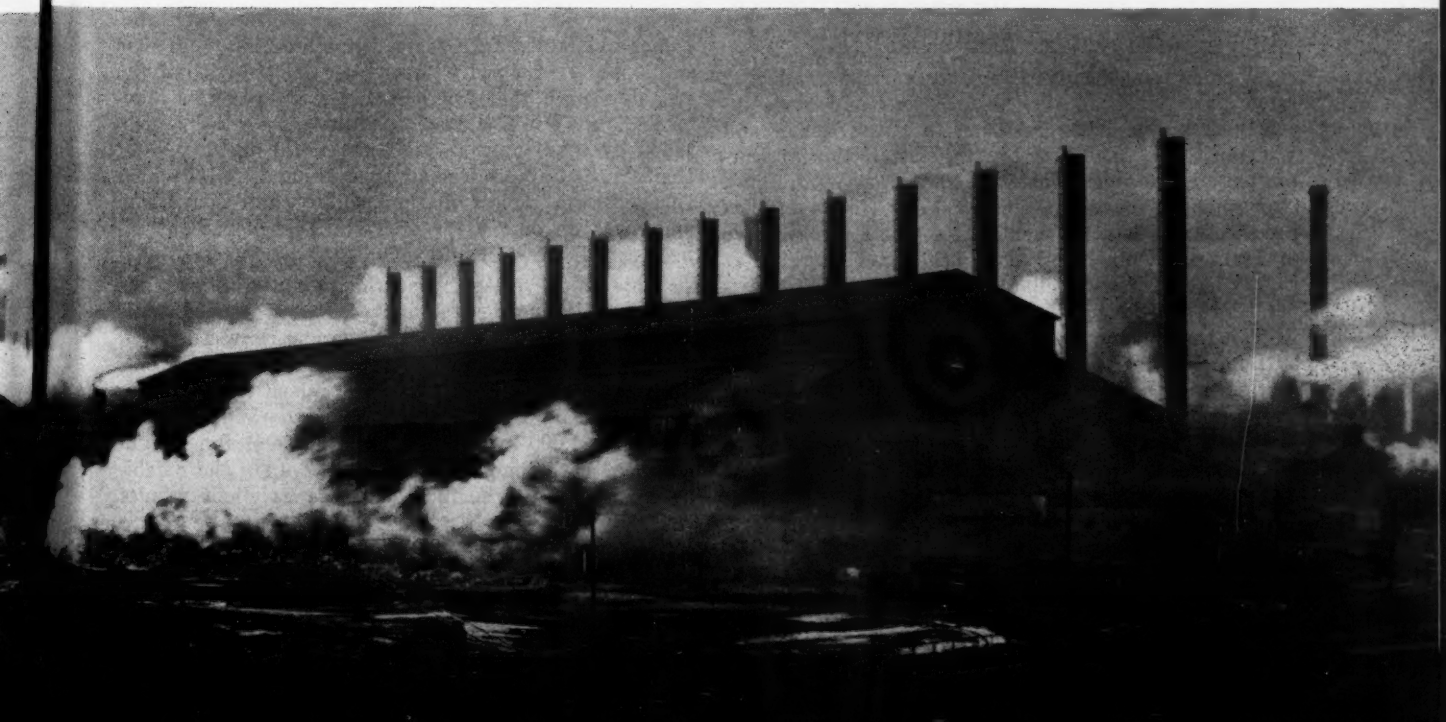
Still we are not worried. We come from stout stock and in forty years of technical editing we have learned to face these things without a qualm—to laugh them off, that is when we can. We are descended from a long line of editors; our forebears were editors and their forebears before them and so it was ad infinitum—it must have been so, otherwise why would we be editors? The disease or whatever it is must be hereditary—certainly no sane individual would choose to acquire it.

So, despite the many pitfalls which may confront us we present this review number—not a bad one at that, we think. We make no apology for it; as far as we know, all we say in it is true and we have honestly tried to pick out the essential features of the year's progress. It is a general summary and we hope it will be accepted as such. Some of the titles may be far-fetched, perhaps, but wherever that happens we have endeavored to make amends by introducing a funny sketch. This again may not please the more serious minded but then there is too much seriousness in the world anyway and a little humor is good for the soul.

As the pages that follow will disclose, it has been a busy year for the power industry and despite a certain feeling of apprehension about general business conditions existing at the moment, the outlook is encouraging. The rush to construct new plants and to install additional generating capacity which started in 1936 has continued this year unabated. There is scarcely a power system of any size in the country which has not had some plan for expansion or improvement under consideration. Throughout the entire year the electrical output of the utility plants has been far above anything in the history of the industry. Manufacturing plants making power equipment have had a prosperous year and in many instances report profits and unfilled orders far in excess of last year. Recently there has been a slight falling off but this probably is only an indication of a flattening out in the upswing in business. The volume of business has risen for five consecutive years with each year better than its predecessor and it would be illogical to expect that such a rise could continue indefinitely. This, as a matter of fact, has been the longest sustained rise in the business history of this country.

So, on the whole, things look good and it is with pleasure that we present so favorable a review of the year's progress. We sincerely hope that next year's may be as good.

Finally, since this is the last issue of the year and knowing we won't have another chance, we take this opportunity of wishing you all a very Merry Christmas and a Happy and Prosperous New Year.



With the boiler only a rack on which to hang water walls, superheater, economizer and air heater; with the world efficiency record held by a station operating on a heat cycle considered passé two years ago; with engineering being pushed around by politics; with turbines shrinking in size but growing in capacity; with top plants and high temperatures playing to the grandstand; the old gods of order and system have fallen to the ground. Yet out of this welter of confusion, brought about by the depression and advent of high temperatures, a dim pattern is already beginning to form.

The WORLD Turned Upside Down

FLITTING over the montage of the year's events like a will-o'-the-wisp, high temperature thoroughly dominates the scene. Well over a hundred important utility installations have been started or announced since the beginning of the current building program. Of these probably 25 per cent are for temperatures of 900 deg. or over, while perhaps 75 per cent are for temperatures not seriously considered in pre-depression days when 750 deg. F. was tops.

Most remarkable of all this is the fact that these high temperature plants are being built on faith—faith in the metallurgist's ability to master creep and the designer's ability to take care of expansion. They were designed with little or no precedent of successful operation, although the importance of high temperature has been fully appreciated for generations.

Operating Background

There is a smattering of experience in the 900 deg. F. range from small foreign installations and more recently from the latest addition to River Rouge and Weirton Steel. The first topping installation at Burlington and the reheat installation at Port Washington offer some guidance in the 800-850 deg. F. range. Experience with the experimental 1100 deg. F. superheater at Trenton Channel and the 1000 deg. F. turbine at Delray offers the only reliable guide to really high temperature operation.

This trend has undoubtedly been influenced greatly by Logan, which is destined to remain one of the important milestones in the March of Power. Pioneering in the true sense of the word, this station jumped to 925 deg. F. two years ago when 850 deg. F. would have been considered high. Facing local system conditions that made it advisable to go the whole way, this top installation is based on the use of a single unit. Using pulverized coal, the million pound boiler is of the dry bottom type because of the coal available and the expected load ratio of 5 to 1. The turbine is the first of the double casing type and the 40,000 kw., 3600 r.p.m. generator the first to use hydrogen cooling.

After this the swing to high temperatures was almost too rapid to keep track of, influenced greatly no doubt by the past record of successful pioneering of the American Gas & Electric Co. Without this impetus from this particular organization it is questionable if progress would have been nearly so rapid even in the face of a successful performance record from Ford's River Rouge plant.

Superheat control in the new high temperature units is, however, one of the present major problems, but will probably decrease in importance as operating data becomes available. In the meantime most of these new units are being fitted with damper control so that the gas flow over the superheater elements can be controlled. At Windsor Station additional control is provided by small burners high up on the front wall of the furnace opposite the superheater and by a divided furnace with a combination radiant and convection superheat on one side. At Twin Branch radiant reheaters will be used.

This is the closest that the newer stations have come to following the lead of the Milwaukee and Kansas city companies, in using combination convection and radiant superheater surfaces for this purpose. The chart, Fig. 1, shows superheat and reheat temperatures at Port Washington Station for a load range of from 31,000 to 81,000 kw. and warrants close study. Regulation of both temperatures depends upon the combination of heating surfaces and the excellent results

obtained are based on over a decade's experience at the company's Lakeside Station.

Port Washington has the distinction of holding the world's record for heat economy by a safe margin. Performance so far this year is given in Table II. Operating on a load factor of around 56.7 per cent, the average heat rate for this 10 mo. is 10,858 B.t.u. per net kw-hr., representing an efficiency of 31.5 per cent. Battersea Station in England last year had an efficiency of 29.63 per cent and a 60.8 per cent load factor.

Although even as late as a year ago, the reheat cycle was safely packed away in mothballs, recent announcement of the 2400 lb., 940 deg. F. extension to Twin Branch definitely brings it out as an active contender where ultimate heat economy and base load operation is considered. The calculated economy of this cycle is some 7 per cent better than a 1200 lb. straight through cycle and some 2½ per cent better than a comparable 1200 lb. reheat cycle.

In spite of this the ultimate development of the reheat cycle will probably remain in doubt for some time. Advances in metallurgy will probably allow a gradual increase in temperature up to about 1000 deg. F., which is about the limit fixed by the disassociation of steam. Pressure limitations between 1400 and 2500 lb. will depend largely upon the performance of the Twin Branch boiler (shown on page 724) and the extra cost of taking care of the higher pressures.

New plants are too numerous to mention in detail, but important data on a few of the more significant ones are shown in the table on page 729. Some of these, such as Bryce E. Morrow and Seward, fall in the general 800 lb. 850 deg. F. class, which, on the basis of first cost, reliability and efficiency, has been selected as more or less standard operating conditions by some companies for new plants of smaller capacity up to perhaps 25,000 kw.

Whether this operating range will continue permanently remains to be seen. The allowable moisture in the turbine exhaust is gradually dropping. A few years ago it was 10 per cent, the Ford high temperature unit is based on 12 per cent and turbine designers are already talking 13 per cent. This favors higher pressures, for with the same turbine efficiency the reduction in condenser loss with higher throttle pressures is much greater than the comparable decrease in initial in total heat for the same steam temperature. There is a good background of successful 1200 lb. boiler operation while the 800 lb. pressure range has sometimes been a difficult one to handle from the boiler standpoint. It is probable that the 800-900 lb., 850 deg. F. straight through group will follow the precedent of early reheat and gradually merge with the 1200-1400 lb., 900-950 deg. F. class.

Top Plants

Another factor which tends to bring the 1200-1400 lb. range into prominence is the large number of top plants. A year ago these obscured all others. This year they are also important and will continue to be a factor for many years to come for there are many of the older plants which are now obsolete but which can be modernized to advantage by top units.

For this purpose 1200-1400 lb. pressure and 850 to 950 deg. F. is admirably suited, the exact conditions depending more or less upon the operating conditions of the old equipment. As time goes on the present 200-300 lb. cross-over pressure will gradually increase up to 400-600 lb. for plants as yet comparatively new. Relieved of the conditions which caused this to be more or less of a fad for the last year and a half, top designs will be designed more rationally in the future, a little more engineering and a little less expediency.

In the 500 to 900 lb. class, there are besides those mentioned, Mountain Creek, a new Texas Station, and River Bend, Delray and South Meadow representing additions with pressures or temperatures or both increased over the previous installation. South Meadow was one of the first mercury installations. What lies ahead of the mercury cycle is difficult to predict. The present situation for large plants is well summarized by Philip Sporn in discussing Twin Branch (E. W., p. 84,

Table I. A few of the many new plants now under construction or recently announced. These few were selected to typify the various trends now prevalent in the industry. Equipment data on these plants is given in a table on page 729

STATION	LOCATION	OPERATING COMPANY	DESIGN ENGINEER	TYPE OF PLANT	Date
PUBLIC UTILITY CONDENSING PLANTS					
Twin Branch	Mishawaka, Ind.	Indiana-Michigan Elec. Co.	American Gas & Electric Co.	Addn.—Condensing	1939
State Line	Hammond, Ind.	Chicago Dist. Elec. Gen. Co.	Sargent & Lundy, Inc.	Addn.—Condensing	1938
Burlington	Burlington, N. J.	Public Service Elec. & G. Co.		Addn.—Condensing	1939
Manchester St.	Providence, R. I.	The Narragansett Electric Co.	United Eng. & Constrs., Inc.	Addn.—Condensing	1939
South Meadow	Hartford, Conn.	Hartford Elec. L. & Pow. Co.	Stone & Webster Engineering Co.	Addn.—Condensing	1938
Delray	Detroit, Mich.	The Detroit Edison Co.	The Detroit Edison Co.	Addn.—Condensing	1938
Bryce E. Morrow	Comstock, Mich.	Consumers Power Co.	Commonwealth & Southern Corp.	New—Condensing	1938
Columbia	Cincinnati, Ohio	Cincinnati Gas & Electric Co.	Sargent & Lundy, Inc.	Addn.—Condensing	1938
River Bend	Mt. Holly, N. C.	Duke Power Co.		Addn.—Condensing	1938
Mountain Creek	Dallas, Tex.	Dallas Pow. & Lt. Co.	Ebasco Services, Inc.	New—Condensing	1938
Seward	Seward, Pa.	Pennsylvania Electric Co.	H. M. Gilbert Engrg. Corp.	Addn.—Condensing	1938
PUBLIC UTILITY SUPERPOSED PLANTS					
Essex	Newark, N. J.	Public Service Elec. & G. Co.		Addn.—Top	1938
Logan	Logan, W. Va.	Appalachian Electric Pow. Co.	American Gas & Electric Co.	Addn.—Top	1937
Windsor*	Beach Bottom, W. Va.	The Ohio Power Co.	American Gas & Electric Co.	Addn.—Top	1938
		West Penn Power Co.	Sanderson & Porter	Addn.—Top	
Springdale	Springdale, Pa.	West Penn Power Co.	Sanderson & Porter	Addn.—Top	1937
Schuylkill	Philadelphia, Pa.	Philadelphia Electric Co.	United Eng. & Constrs., Inc.	Addn.—Top	1938
Millers Ford	Dayton, Ohio	Dayton Power & Light Co.		Addn.—Top	1937
MUNICIPAL PLANTS					
Austin	Austin, Minn.	Board of Water & Light Comm.	Ralph D. Thomas	Addn.—Condensing	1937
Quindaro	Kansas City, Kans.	Board of Water, Light & Power	Burns & McDonnell Eng. Co.	Addn.—Condensing	1938
Rochester	Rochester, Minn.	Board of Water & Light Comm.	Burlingame & Hitchcock	Addn.—Condensing	1937
Ottawa St.	Lansing, Mich.	Board of W. & Elec. L. Comm.	Burns & Roe, Inc.	New—Cond. & B. P.	1938
INDUSTRIAL PLANTS					
Albert Lea	Albert Lea, Minn.	Wilson & Company	Wilson & Company	New—Back Pres.	1937
South Works	Chicago, Ill.	Carnegie-Illinois Steel Co.	United Eng. & Constrs., Inc.	New—Condensing	1937
Charleston	Charleston, S. C.	W. Virginia Pulp & Paper Co.	G. R. Wadleigh	New—Cond. & B. P.	1937
Midland	Midland, Mich.	The Dow Chemical Co.	The Dow Chemical Co.	Addn.—Top	1938

* Windsor is owned jointly by two companies. The West Penn P. Co. boiler expansion program is not yet decided in detail. The Ohio P. Co. program includes two new boilers, one a divided slag top furnace with a combination superheater on one side, the other boiler a dry bottom type with special temperature control burners operating in conjunction with a bypass damper.

Oct. 9, 1937), "It was frankly felt that in the light of technical difficulties that have been encountered heretofore in the expansion of the size of the mercury boiler, in particular, that no consideration of the cycle was warranted, particularly if economics approaching the

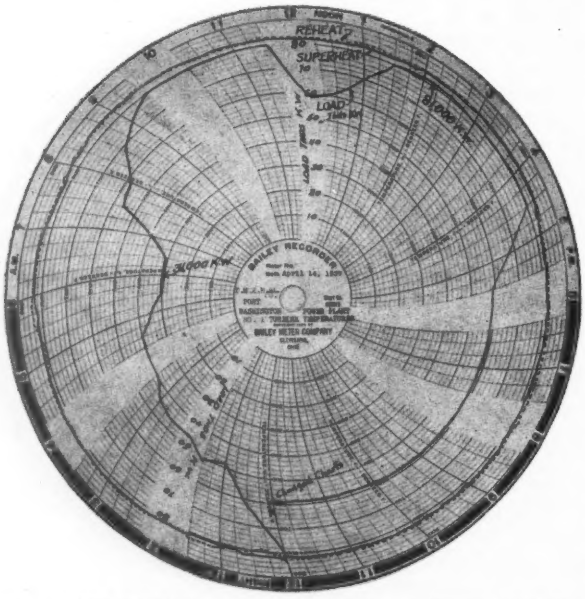


Fig. 1. When superheat and reheat temperature is discussed, performance of the radiant-convention combination at Port Washington must be given serious consideration. This chart taken on April 14, 1937, shows a load range of from 31,000 to 81,000 kw. and is typical of the consistency of the steam temperature characteristics of the boiler. Each major division on the chart is 100 deg. F. and each minor division 20 deg. F. Maximum variation of the reheat temperature is about 3.3, of the superheat temperature about 2 per cent plus or minus

order of those obtainable by mercury could be obtained by a straight steam cycle."

More recently before the A. S. M. E., W. L. R. Emmett, whose name cannot be separated from the mercury cycle, said, "As a consequence, I now, for the first time, feel sure that the process, with which I have worked and worried for so long, is in condition to enrich the world in almost every kind of activity where power is made from fuel." He was referring specifically to the work on the smaller boiler units covered in last year's review.

Of the top plants, Springdale, Logan and Millers Ford are completed or nearing completion. Windsor, Essex and Schuylkill are well under way, while Burlington and Northwest are the latest undertakings on which work has just started. Manchester is an addition to an older station, a 1200 lb. high temperature straight through turbine, the largest single unit yet installed in New England.

The four industrial plants pretty well cover the range of industrial practice. The Wilson & Co. Albert Lea plant is an excellent example of modern design for back pressure operation. The Carnegie-Illinois Steel Corp.'s South Works plant typifies the trend toward large industrial plant practice with units approaching central station proportions. The Charleston plant of the West Virginia Pulp & Paper Co. is the result of a long period of successful high pressure work by this company, while the Dow Chemical installation is a 1200 lb. top, something still relatively new in industrial practice, but destined for much wider application in the future.

Quindaro with its new 30,000-kw. unit sets a new record for unit sizes in municipal plants, while Ottawa Street is unusually interesting due to the combination of power generation, district heating and the sale of high pressure steam with an unusually flexible arrangement of units. Both Rochester and Austin have water cooled stokers and will be equipped to burn coal or natural gas.

While pulverized coal has somewhat dominated the scene, stokers have held their own in new construction. Provo and Omaha have chain grates, Delray will have underfeeds. Water-cooled stokers are now in operation. Three of this type, at Rochester, Austin and Seward, are represented on the list of stations in this issue. Cedar Rapids, where the early work is done, has a new unit (p. 598 October issue) and several industrial installations are under way.

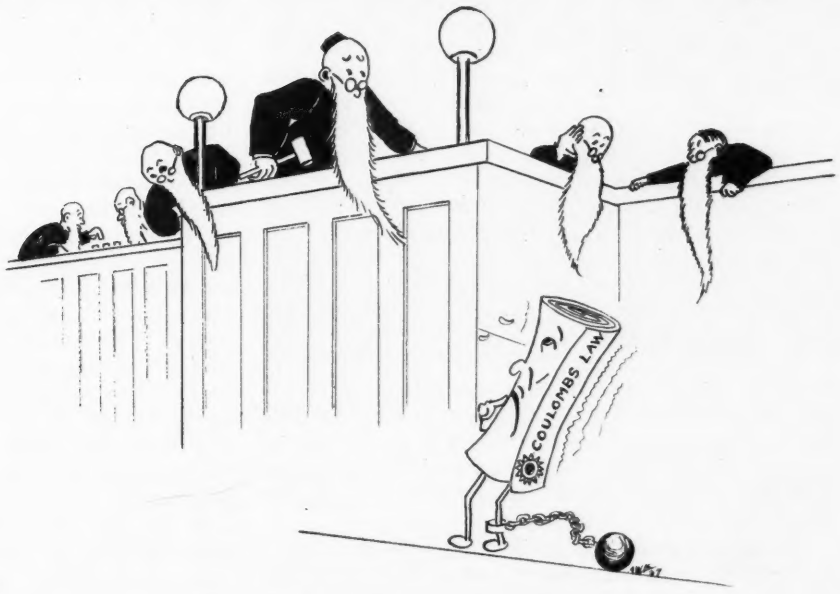
Although the report of the Federal Power Commission raised a storm of adverse criticism and violent denials of an impending power shortage, the flood of new construction bears witness to the fundamental truth of the F. P. C. claims. In fact the danger is not yet passed and in some cases acute conditions have been avoided this fall only because of the recent slump in the power load caused by the general business recession. Unquestionably this is a temporary condition and both business and the power load will continue at a more gradual but constant rate.

For the industrial field both the 400 and 600 lb. pressure ranges have been popular with temperatures

Table II. Port Washington, one of the so-called low cost stations, has consistently held the world's record for low heat rate by a wide margin and the above data show the performance for the first part of 1937. Two years ago when the station went into service (October 14, 1935), the reheat cycle was generally considered a thing of the past or of the far distant future. This impressive record, coupled with the announcement of the new Twin Branch extension, shows that the reheat cycle is still very much alive

MONTH	OUTPUT, KILOWATT-HOURS			BTU. KW-HR.		
	Gross	Aux.	Net	Gross	Aux.	Net
Jan.	18,359,000	1,125,827	17,733,173	10,678	678	11,356
Feb.	37,489,000	1,926,968	35,562,032	10,398	563	10,961
Mar.	23,802,000	1,281,259	22,520,741	10,414	593	11,007
Apr.	26,530,000	1,442,464	25,137,536	10,353	594	10,947
May	33,274,000	1,731,669	31,542,331	10,230	561	10,791
June	35,166,000	1,770,473	33,395,527	10,132	537	10,669
July	41,961,000	2,062,370	39,898,630	10,235	530	10,765
Aug.	42,988,000	2,099,808	40,888,192	10,275	528	10,803
Sep.	40,862,000	2,050,057	38,811,943	10,206	539	10,745
Oct.	28,122,000	1,515,084	26,606,916	10,292	586	10,878
Totals	329,103,000	17,005,979	312,097,021			
Aver.				10,297	561	10,858

ranging from 650 to 700 deg. F. Industrial plants serve a definite and specific load and usually involve the use of process steam. Initial steam conditions are set by factors other than power generation alone and extreme high temperatures are involved only in exceptional cases like the River Rouge plant. The lower temperatures involved make possible the use of equipment that has been more or less standardized through past practice in the utility field. This tendency to emphasize progress in the utility field has been criticized, yet it is from the utility field that the industrials must draw for experience if progress in the industrial field is to continue. Few industrial organizations are large enough to depend entirely upon their own experience for progress and few industries are justified in pushing power developments into new and untried fields.



Washington Ruling Limits Coulombs Law

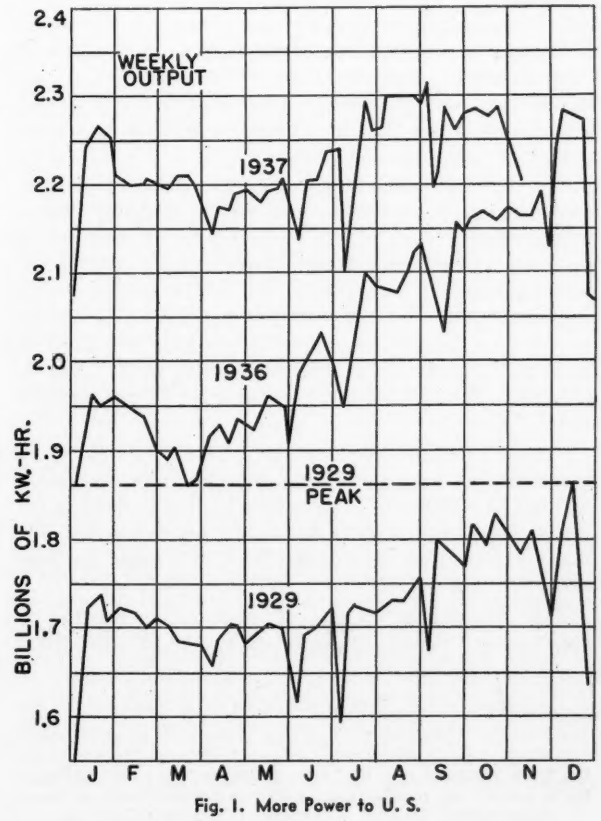


Fig. 1. More Power to U. S.

Recent discoveries upset ideas about repulsion of like electrical charges. But rural electrification goes forward, also expansion of industrial power facilities

STRANGE as it may seem, the most startling ruling on a law that has come out of Washington in recent months went entirely unnoticed by the gentlemen who write the newspaper headlines. This ruling, moreover, never got to the Supreme Court; it was not contested in any way nor were any injunctions sought to restrain or limit its action. As a matter of fact, even though this ruling concerned electric power, not a single power company as much as questioned its constitutionality.

Before we discuss the details of this ruling, however, perhaps we should consider some of the other important developments of the year in the field of electricity. As always, in presenting a review of activities in the electrical field, it is difficult to set the limits to which the discussion should be confined. A review for a technical publication such as this could, of course, be confined only to technical progress, but technical progress is often closely related to economic questions and these in turn are related to matters of political import. So, in this article we will endeavor to give a very brief account of the status of the field in general, touching upon political matters where it seems necessary.

To begin with, there is the electric load or pro-

duction curve which has been hurtling skyward at breakneck pace. This astonishing increase in the use of electricity by the people at large is one of the most significant elements in the picture as a whole. As will be noted from the curves shown in Fig. 1, throughout the entire year, the electrical output of the public utility plants has been far above anything in the history of the industry. It has averaged well over two billion kilowatt hours a week and in the latter half of the year at times it went above 2,300,000 kw-hr. The increase over that of last year for the second half of the year was not as great as during the first half but that is probably only an indication of a flattening out in the upswing in business.

Naturally, the great increase in the use of electricity has been reflected in a tremendous expansion of the facilities for generating, transmitting and distributing electrical energy. There is scarcely a public service company of any size in the country that has not had an expansion program of some sort under way these last two years.

Of great significance in the growing use of electricity is the phenomenal increase in rural electrification both as sponsored by the Rural Electrification Administration and the Public Utility Companies. An important factor in this expansion aside from the increased income of the farmers is the steady lowering in the cost of rural line construction. Whereas a few years back rural lines cost anywhere from $1200 to $3000 per mile, this year some lines were laid out to cost not over $600 per mile, including all overheads.

The excellent condition of the electrical industry was reflected in the largest Edison Electric Institute Convention this year since its formation in 1933. Despite the fact that there is much pessimism on the part of utility operators regarding government control and competition, the utility outlook in general is optimistic.

Government policies, however, continue to be a disturbing factor in the utility situation and a review of the year's activities in this respect reveals one continuous series of charges and countercharges by those on the respective sides of the controversy. The year's history bristles with suits and injunctions, legal affrays and a great deal of bitterness. Whatever truth and justice may underlie the various charges and countercharges which are hurled about from newspaper and magazine headlines, in radio speeches and convention proceedings by the proponents of both factions it is so colored with prejudice and selfishness that it is all but lost. The situation, as always in a long drawn out controversy of this kind, has reached a point where reasonable discussion of the subject has become practically impossible. Prolonged controversy on any subject is likely to engender such bitterness that fair and dispassionate consideration becomes difficult. For nearly a decade now the forum for the discussion of electric power has had the appearance of a battlefield and there is little likelihood of an armistice in even a reasonable future. Many battles remain to be fought, all of them in the time consuming atmosphere of the courts. The fate of the so-called holding company is still in the balance. The government, after using as a basis for quashing other litigation on the subject the claim that the mandatory injunction against the Electric Bond and Share Co. would settle all questions raised in the other litigation then proceeded to narrow its own case down to the separability of Sections 3 and 4 of the Act, so that final determination of that case may still leave the constitutionality of the Act unsettled. Last spring the utilities and the government joined hands in an effort to "by-pass" the Circuit Court of Appeals but the Supreme Court on June 1 denied the application of *certiorari.* Thus the case must slowly fight its way through the long and arduous channels of legal procedure to its final outcome, whatever that may be.

In the meantime, another disturbing development has come up to give the utilities cause for apprehension, justified or otherwise. This is the proposal by President Roosevelt to create seven regional power planning boards for the nation similar to that involved in T. V. A. The President, however, in a speech made at the opening ceremonies of the Bonneville project in September, gave assurance that the planning boards to be set up under this new proposal would not be all powerful authorities which would destroy state lines or set up dangerous centralized control.

In the industrial power field there has also been considerable expansion of generating facilities. Foremost in importance in this respect is the placement of an order by the Ford Motor Co. for a third 110,000-kw. turbo-generator. These units are the largest in use in industrial power plants but they are closely seconded by units of 25,000 kw. capacity recently installed in steel mill plants. One steel mill plant is laid out to accommodate a 50,000-kw. generator for future installation.

In the turbine-generator field, the size of 3600 r.p.m. machines has been increasing and these are now made as high as 50,000 kw. The use of hydrogen cooling for large generators also is becoming quite general and many of the units ordered or placed in service this year are hydrogen cooled.

The latest practice in transmission line practice in this country is still exemplified by the 267 kw. lines

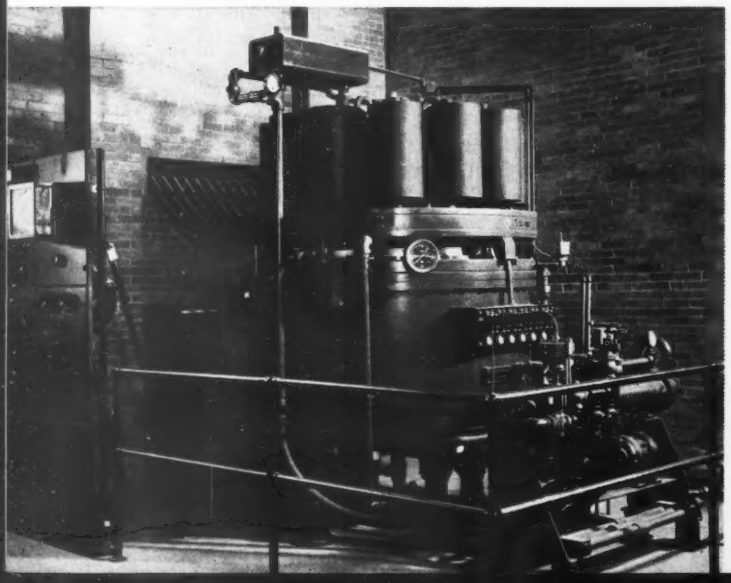


Fig. 2. For the first time in the history of America's iron and steel industry, a mercury arc rectifier was installed to provide direct current in large amounts for steel mill service. (Photo, Allis-Chalmers)

between Boulder Dam and Los Angeles, but in Europe, Paris has blazed the trail for the use of a much higher underground cable voltage than anything used on this side of the Atlantic. This development involves the first 220 kv. cable, a whole hundred kilovolts higher than the highest voltage cables used here.

The use of capacitors for various purposes has increased during the year and shunt capacitors are being used on distribution systems with good results. Where high speed operation of switches and circuit breakers is an important fact, capacitors are being used to supply the instantaneous energy required for tripping these devices. Developments in electronics and the application of electron tubes are too numerous to mention. More and more, electronic devices are becoming a standard part of industrial and power plant equipment and power engineers are losing a little of their timidity towards these devices. In the field of voltage regulation, electron tube units are available in commercial forms for generators up to 10,000 kw. but there are no technical reasons for not increasing this value should occasion demand. For relaying purposes, tubes are finding more application but the licensing situation hampers advance in the field to a certain extent. An interesting development in the use of the thyratron is a half cycle magnetizer for magnetizing small magnets such as are used in meters and relays. This application involves the use of a thyratron tube to pass a single half cycle of current under perfectly controlled conditions. An outstanding development in the instrument field this year was a new high speed cathode-ray oscillograph capable of recording high speed transient phenomena with a sealed-in cathode-ray tube. Another development in instruments was a double photoelectric recorder which records simultaneously on one chart two electrical quantities as low as one microampere per full scale deflection representing a power consumption of only 0.00000001 watt from the measured circuit. In the field of pure research, the cyclotron has undergone considerable development and a number of large units are under construction or under way in various laboratories throughout the country. These of course will be used in atomic disruption studies. At the same time Westinghouse has been building a large "atom smasher" of the straight cathode ray tube type utilizing a Van de Graf type generator. This brings us to the matter which we mentioned at the beginning of this article since the law referred to, is mixed up with a high voltage generator of the Van de Graf type installed in one of the laboratories of the Bureau of Standards at Washington, D. C. Of great significance in the field of fundamental physics, this refers to the disclosures made this year of Dr. Merle Tuve's remarkable discovery of the attractive force between protons—the antithesis of the time honored Coulomb's Law by which like charges repel one another. Until this discovery by Dr. Tuve and his associates at the Bureau of Standards, Coulomb's Law had held inviolably—no variation in its working had even been observed. Now, however, as a result of bombardment experiments with the high voltage atom smasher at Washington, this law is shown to be not only invalid at distances which obtain in the neucleus of the atom but actually reversed. Like charges, instead of repelling each other as they should according to Coulomb's Law, are drawn together by an

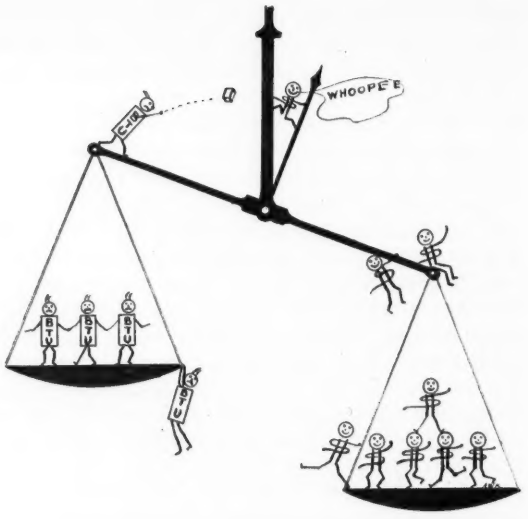
Fig. 3. A new and improved, a.c. network analyzer on which networks can be simulated in load and voltage regulation studies. (Photo, General Electric)

attractive force. This force, tremendous in magnitude compared to the Coulomb forces holds protons (and neutrons) in close proximity within each atomic neucleus and in this sense "holds the world together." This force Tuve and his associates found was 10^{36} times more powerful than the Newtonian force of gravitation, in fact if the Newtonian force of gravitation operated on the same scale, a feather on the earth's surface would weigh billions of tons. The full significance of this startling discovery will probably only be realized as time goes on. In the field of communication the year discloses innumerable advances in high frequency technique. Of particular interest in this connection is the new 95 mile 1,000,000 cycle line between New York and Philadelphia which will carry 240 separate two-way telephone messages or it can be used for transmission of television programs. Television itself has undergone further technical development and the indications are that it will reach a commercial stage sometime in 1938 on a limited scale, however. Already the two major systems, R. C. A. and Farnsworth, have spent some $9,000,000 in television development. An important feature of this year's American television development was the introduction of a projection kinoscope capable of projecting a clear television picture some 3 by 4 ft. in area. In Europe, that is in England, Germany and Russia, practical television has been a reality for sometime but the American interests are unwilling to place it in the hands of the public until a fully reliable and satisfactory system is developed.

The use of mercury arc rectifiers has increased and during the year the first large grid controlled mercury arc rectifier was placed in service in a steel mill. For large power systems involving many generating sources, the network analyzer becomes increasingly useful and this year a new analyzer with a centralized metering system was developed.

While it is impossible in a short article to deal with personalities no review of the electrical field would be complete without at least mention of the death of Elihu Thomson on Mar. 13. Elihu Thomson was a world figure, one of the great pioneers of the industry. With over 700 patents to his credit, he lived to receive and enjoy the appreciation of a justly grateful world for his contributions to the comfort and happiness of the people all over the civilized world.

The cycle adopted must give the maximum heat economy consistent with the cost of the necessary equipment. Roughly, the total generating cost is about evenly divided between capital and operating charges, about 70 per cent of the latter being for fuel. Industrial plant economy largely predicated on utilization of turbine exhaust.



Balancing the B. T. U. and the Dollar

FOR WELL OVER A DECADE there has been no fundamental change in the heat cycles in common use although the internal details of the cycles have been in a continual state of flux. The general idea is to increase efficiency by working as close to the theoretical limits as possible and by reducing heat losses, particularly, those two major unavoidables at the ends of the cycle, flue gas and condenser water. Equipment to do this costs money, not in direct proportion but according to the law of diminishing returns. The problem is further complicated by the fact that fuel costs vary according to location and time. Equipment costs vary too, but independently.

The problem of the designer is to get the highest commercial efficiency, the lowest total cost per net kilowatt hour remembering that fuel costs are roughly 35 per cent, capital costs 50 per cent and operation and maintenance costs 15 per cent of the total. Every plant has its peculiar problems, influenced by such factors as the price and type of fuel, load factor, condensing-water facilities, and foundations. Today certain social, political, and economic influences, common to all plants must be recognized by the design engineer. There is a definite demand by the public for lower electric rates. The public is also becoming more critical of the noise and ash nuisance and the use of special equipment to avoid these complaints add to the first cost of the plant.

Cycle Limits

Lower limits of the cycle are definitely fixed within a narrow band by available water temperatures. The upper limits of pressure and temperature are fixed largely by metals and fabrication methods available for construction. A further limitation is set by the moisture in the turbine exhaust, allowable without excessive blade erosion, again largely a matter of metals and construction methods and becoming of increased importance as turbine efficiency is increased.

When the extraction cycle was gaining supporters early in the 1920's, pressure had crept up to roughly 400 lb., temperatures to 700 deg. F. and the economizer was firmly established. The extraction cycle increases efficiency by transferring a portion of the condenser loss to the feedwater. The ultimate limit is reached as the feedwater temperature approaches the drum saturation temperature. Extraction, therefore, encroaches on the economizer and as the economizer decreased in importance the air heater gradually took over its function of reclaiming waste heat from the flue gases.

The Economizer Comes Back

At one time the economizer was well on its way to oblivion and was saved perhaps by water walls and higher pressures. The latent heat of vaporization decreases as the pressure increases. This decrease, coupled by the fact that water walls do a large portion of the vaporization, reduced the boiler surface proper so materially that the air heater had difficulty in handling the waste heat job alone. This meant choosing between the loss of heat at one end or the other and resulted in a more rational division of responsibility between extraction and the economizer. The decision may have been influenced by the feed pump problem. With maximum extraction the feedpumps must handle extremely hot water which has proved troublesome, or, the high pressure heaters must be built for full boiler pressure which is costly. At any rate, the economizer in abbreviated form is establishing a mild comeback. Of 100 large new boilers 47 have economizers, 86 air heaters and 39 both economizers and air heaters.

Development of the regenerative or extraction cycle was, to a large extent, coincident and involved with

the reheat cycle. Development of reheat was primarily an attempt to increase the thermal efficiency although it was influenced by the fact that pressures had increased to the point where straight expansion was giving excessive moisture in the turbine exhaust.

One of the by-products of this era, however, was a background of high pressure boiler operating experience that made the present tidal wave of topping plants possible, although it must not be forgotten that the 1200-1400 lb. pressure development began at Edgar and Lakeside as topping installations.

Reheat

Two years ago the reheat cycle was laid carefully to rest, not entirely without critical comment. High temperatures of 900-950 deg. F. made possible an 800 to 1200 lb. straight through cycle which gave efficiencies making reheat difficult to justify. In the meantime the value of 10 per cent allowable moisture in turbine exhausts had been raised to 12 per cent and turbine designers are now talking 13 per cent.

About this time, however, Port Washington, the last of the old guard, the culmination of two decades development in the industry toward a simplified low cost (less than $80 per kw.) single unit plant, was put into service and immediately set a new world's record. More recently the announcement of the Twin Branch has brought the reheat cycle very much to the fore, although in this particular case reheat as such is perhaps secondary to a full investigation of ultra high boiler operation with a long time view toward topping medium pressure plants which today are still comparatively new.

Figure 2 shows the preliminary flow diagram of this station although many of the details have not been worked out. It is a straight regenerative-reheat cycle and the cross compound unit will operate with variable crossover pressure, the maximum value being about 415 lb. The feed heating cycle will contain five closed and one deaerating heater, with an evaporator operating between the two lowest extraction stages of the low pressure turbine. The auxiliary pump turbine will probably exhaust to a separate condenser as shown, rather than to a heater in the feed heating cycle, although this has not definitely been determined.

Steam Driven Auxiliaries

This turbine drive is particularly interesting in view of the tendency toward turbine auxiliary drives which has been noticeable recently in top plants, largely to obtain the steam for stage heating lacking on the old low pressure turbines. At West End (see flow diagrams p. 446 August 1936) the feedwater pump turbine is bleed. Exhaust from the turbine increases the feed temperature from 202 to 237 deg. F. while the extracted steam increases it from 237 to 268 deg. F.

This was not a factor at Twin Branch but the necessity for feed pump economy was. As pressures go up the feed pump power requirements increase rapidly. This increases the importance of pump efficiency and the need for a flexible control to cut excess pressure pumping. It will be recalled that State Line, when changing to higher pressures, purchased reciprocating feedpumps because of the higher efficiency.

Centrifugal pumps are, however, almost universally used for this service and recently the pump speeds in Europe have been increased to 7000 and 10,000 r.p.m. with reports that higher speeds were planned. These speeds, higher than the maximum speed of 3600 r.p.m. with 60 cycle motors, virtually means a shift to turbine drive for the turbine offers good economy for direct drive and is susceptible to control. The turbine drive at Twin Branch was made to answer both the speed and control demands. Note from the diagram that the feedwater is handled by three pumps; the hotwell pump to the deaerating heater; tank pump through the remaining closed heaters; finally by the feedpump to the boiler.

Control and Desuperheaters

Steam flow has been a factor in feedwater regulation for some time and certain parts of the feedwater system are occasionally tied in as an integral part of the combustion control. At Fisk (see p. 576, October 1937) provision is made to control excess pressure in accordance with load. Development of complete combustion control capable of coping with the complicated problems of the modern plant has been one of the important steps of the past few years. The scope of automatic control has constantly widened and at the South Works

Fig. 1. High boiler efficiency is the starting point of all cycles but the operator no longer depends upon visual inspection of the furnace to get the best out of the boiler. Combustion controls do the work while instruments enable him to add the human touch which controls, no matter how sensitive, lack

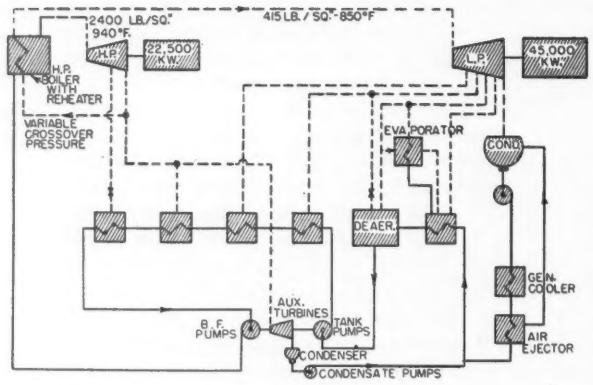


Fig. 2. Twin Branch Station will operate on a 2400 lb. reheat cycle. The flow diagram will be something like this but the details are not all definitely set led. This is part of a far-sighted development program looking forward to the eventual topping of 600 and 800 lb. plants

plant of the Carnegie-Illinois Steel Co. generator frequency shares the responsibility of master loading control with steam header pressure. This same control handles three fuels, blast furnace gas as the primary fuel with natural gas and oil, either separately or simultaneously, as auxiliary fuels. A recent installation by the same company at its Ohio Works handles blast furnace gas as a primary fuel with pulverized coal as auxiliary. The change over is entirely automatic in accordance with load and the availability of the primary fuel.

Closely related to control, hardly concerned with the heat balance, yet, an indispensable part of the modern top plant, is the desuperheater. Its function is to bypass the high turbine in emergencies and make the high pressure boiler output available to the low pressure turbine at the desired pressure and temperature. Both speed and large flows are involved. In some cases an additional service may be called for. The exhaust temperature of a turbine operating at constant back pressure as in top service, increases as the load drops. If the initial conditions have been selected for high load factor operation, the exhaust temperature at occasional light loads may exceed the allowable limit for the old equipment. At Springdale a desuperheater is installed in the high pressure turbine exhaust

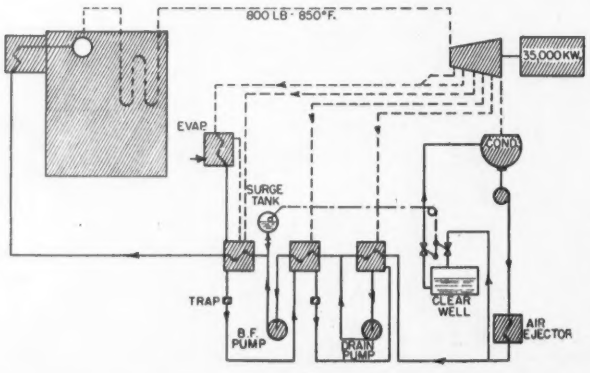


Fig. 3. Bryce E. Morrow is typical of the present modera'e pressure straight through cycle. The Commonwealth & Southern Corp. have more or less standardized on 850 lb., 850 deg. F. for its present construction program

to hold the temperature to a maximum of 650 deg. F. Operation is controlled by the position of the turbine governor and a thermometer in the turbine exhaust.

Topping Springdale resulted in an appreciable increase in efficiency and worthy of mention because it is perhaps typical of what can be expected of topping installations. The calculated heat rate of the old equipment at Springdale for 100,000 kw. using the most efficient equipment was 15,500 B.t.u. per kw-hr. With the 50,000 kw. topping turbine and a load of 150,000 kw., the heat rate is reduced to 12,100 B.t.u. or an efficiency of 28.2 per cent. At full load of 180,000 kw., the old heat rate was 18,170. With the new 50,000 kw. unit added to give a capacity of 230,000 kw. the heat rate will be reduced to 13,800. The old average yearly heat rate for Springdale was 17,445 per net kw-hr. at a 68% load factor.

Bryce E. Morrow and John C. Weadock Stations both belonging to the same company are similar and perhaps typical of general contemporary design in the 800 850 lb. pressure range. The Morrow turbine is bled at five points as shown by Fig. 3, the upper one being utilized for scale cracking in the high level

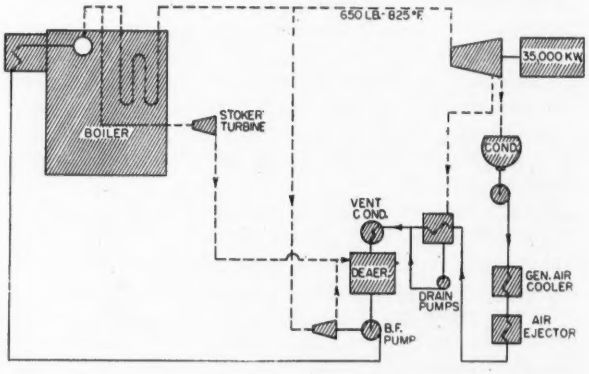


Fig. 4. Seward Station will use water cooled underfeed stokers, an economizer but no air heater, and one stage of extraction heating. The design heat rate at 35,000 kw. is about 13,000 B.t.u. per kw.-hr.

evaporator which utilizes the high pressure heater as a condenser. Drains are cascaded to the low pressure heater and then pumped to the heater discharge.

Delray too (see page 306, May 1937), will use all closed heaters with the drains cascaded to the lowest heater and then pumped to the discharge side. Montville uses four extraction heaters. The drains are also cascaded but pass to the main condenser through a drip cooler. Details of this kind are influenced largely by past practice of the company and differences of opinion as to the relative value of heat and dollar efficiency. Location of the evaporators is another point in question. At Twin Branch the evaporator is between the two lowest bleed points, at Morrow between the two highest, while at Delray it is about midway between the two extremes. Auxiliary drives vary also. In accordance with past practice of the Detroit Edison Co. auxiliaries at Delray are driven by direct current motors with power to be supplied by a separate d.c. turbine driven unit. Another characteristic feature is the lift pump for delivering of water from the hotwell

Data on a number of new American utility, municipal and industrial plants

STATION	THROTTLE PRES. LB/SQ.IN.	THROTTLE TEMP. °F.	BOILERS NO.	BOILERS CAPACITY LB./HR.	BOILERS SUPERHEATER SQ.FT.	BOILERS REHEATER SQ.FT.	BOILERS T. CONT'L	BOILERS ECON. SQ.FT.	BOILERS AIR HEATER SQ.FT.	BOILERS AIR HEATER TYPE	BOILERS ASH COL.	BOILERS W.W. SQ.FT.	FURNACES VOL. CU.FT.	FURNACES H.REL'S B.T.U./CU.'	FURNACES TYPE BOT.	FURNACES TYPE FIRING	AUXILIARIES F.D. FANS NO.	F.D. FANS C.F.M. EACH	F.D. FANS IN H_2O	F.D. FANS °F.	AUXILIARIES I.D. FANS NO.	I.D. FANS C.F.M. EACH	I.D. FANS IN H_2O	I.D. FANS °F.	GENERATING UNITS NO.	GENERATING UNITS RATING KW.	GENERATING UNITS SPEED R.P.M.	GENERATING UNITS B.PRES LB./SQ.IN.	GENERATING UNITS COND'SR SQ.FT	GENERATING UNITS GEN-COOL
PUBLIC UTILITY CONDENSING PLANTS																														
TWIN BRANCH[1]	2300	940	1	550,000	←					REGEN	—NOT YET DECIDED—					P.C.				→				→	1	67,500	①	①		HYD
STATE LINE[2]	1200	825	2 1	500,000 385,000	8135 8135	11500 8025	HAND DAMPER	31,191 14,686	79,750	TUBE	EL.ST.	3040	19,600	26,500	SLAG	P.C.-GAS	2	88,000	10.2	100	2	132,500	13.2	350	1	150,000	1800	0.49	90,000	HYD
BURLINGTON	1265	950	2	575,000	←			—NOT YET DECIDED—								P.C.-OIL								→	1	100,000		0.49		
MANCHESTER ST.	1200	925	1	430,000	8100	8600	BYPASS	16,650	29,400	REGEN	—	6700	21,244	25,000	DRY	P.C.-GAS	2	65,000	9.2	100	2	118,500	22	320	1	40,000	3600	0.69	28,500	HYD
SOUTH MEADOW	850	900	1	425,000	5200	9300	BYPASS	23,000	11,000	REGEN	—	4500	22,000	25,800	DRY	P.C.-GAS	2	75,000	12	80	2	137,000	12.5	450	1	40,000	3600	0.7	36,000	AIR
DELRAY	815	900	5	344,000	8188	9353	BYPASS	18,300	32,200	TUBE	FANS	4948	28,500	20,400	—	STOKER	2	53,300	15.7	100	1	189,000	15.5	350	2	75,000	1800	0.49	53,620	AIR
BRYCE E. MORROW	800	850	1	400,000	7400	9500	BYPASS	28,500	54,100	TUBE	CYCL.	4100	22,000	24,500	DRY	P.C.	1	130,000	11.8	100	1	215,000	14	300	1	35,000	3600	0.63	33,000	HYD
COLUMBIA	665	900	2	300,000		7980	BYPASS	15,985	34,800	TUBE	—	7176	4750	84,600	SLAG	P.C.	1	109,000	9.25	100	1	180,000	17	390	1	65,000	1800	0.49	51,800	HYD
RIVER BEND	665	825	2	275,000	16,900	8000	BYPASS	—	31,400	REGEN	—	6000	16,700	22,000	DRY	P.C.	1	106,000	10.7	80	1	192,000	10.2	390	1	55,000	1800	0.98	50,000	AIR
MOUNTAIN CREEK	675	830	2	200,000	13,800	2400	BYPASS	1500	19,600				7100	36,000	DRY	GAS-OIL	1	62,800			1	98,200			1	35,000	1800	0.75	27,100	AIR
SEWARD[3]	650	825	2	200,000	16,320	5820	—	8320	—	—	—	1047	9500	30,300	—	W.C.STOK.	← NOT PURCHASED →				2	64,800	9	375	1	35,000	3600	0.615	29300	HYD
PUBLIC UTILITY SUPERPOSED PLANTS																														
ESSEX	1265	950	2	605,000	3060	15,400	BYPASS	16,280	73,600	REGEN	EL.ST.	6753	27,930	27,000	SLAG	P.C.-OIL	1	185,000	11	120	1	320,000	16	360	1	50,000	3600	240	—	HYD
LOGAN	1265	925	1	1,000,000	20,800	26,000	BYPASS	25,850	90,400	REGEN	SCRUB	20,300	41,000	29,800	DRY	P.C.	2	145,000	10.4	100	2	274,000	19.9	357	1	40,000	3600	230	—	HYD
SPRINGDALE	1200	925	3	500,000	6369	19,070		16,700	32,700	TUBE	EL.ST.	5286	16,130	38,100	SLAG	P.C.	2	86,000	12	100	2	166,000	16	455	1	50,000	3600	330	—	HYD
WINDSOR[4]	1265	925	1 1	750,000 750,000	7717 13,000	15,580 18,400	FIRING BYPASS	34,800 11,000	47,800 47,800	REGEN REGEN	— —	7743 7160	40,000 33,800	23,700 28,500	DRY SLAG	P.C. P.C.	2 2	112,500 112,500	11.5 11.5	100 100	2 2	225,000 225,000	22 22	400 400	1 1	60,000 60,000	3600 3600	250 250	—	HYD HYD
			←									NOT YET DECIDED												→					
SCHUYLKILL	1265	900	2	600,000	11,090	16,300	BYPASS	11,500	55,000	REGEN	EL.ST.	8190	27,300	27,300	SLAG	P.C.	2	102,500	14	95	2	187,500	23	385	1	50,000	3600	245	—	HYD
MILLERS FORD	1200	900	2	375,000	3400	10,800	BYPASS	20,650	24,000	TUBE	EL.ST.	2600	12,100	39,500	DRY	P.C.	1	113,000	12	100	1	200,000	13	450	1	25,000	3600	250	—	HYD
MUNICIPAL PLANTS																														
AUSTIN[5]	400	750	1	80,000	9600	3900	—	—	11,400	REGEN	—	1112	4800	28,000	—	W.C. STOK.	1	23,000	8	80	1	43,000	4.5	400		PRESENT 275 LB. TURBINE USED				
QUINDARO	400	725	1	180,000	16,300							1900	11,200	22,400	SLAG	P.C.	1	67,600			1	109,000			1	30,000	1800	0.75	40,000	AIR
ROCHESTER[6]	400	650	1	125,000	10,190	1750	—	—	7000	REGEN	—	1950		30,000	—	W.C. STOK.	1	65,000	6.5	70	1	120,000	8	400	1	7500	3600	0.63	10,000	AIR
OTTAWA ST.	825	900	2	225,000	2800	7000		6800	42,800		EL.ST.	3200	8200	32,200	SLAG	P.C.	2	35,000			2	115,000			1 1 1	25,000 4000 2500	3600	0.50 22.4 15	23,000 — —	HYD AIR AIR
INDUSTRIAL PLANTS																														
ALBERT LEA	295	520	3	40,000	4900	400	—	—	7900	TUBE	—	1050	4050	11,350	DRY	P.C.	1	25,200	7.14	195	1	35,200	5.26	350	1 1 1	1500 1000 500	3600	24	—	AIR
SOUTH WORKS[7]	450	750	3	300,000	22,000	6450	—	7180	52,400	REGEN	—	5675	17,150	24,600	DRY	GAS-OIL	2	45,000	11	100	2	160,000	14	590	1	25,000	1500	0.98	20,000	AIR
CHARLESTON	550	700	2	225,000	11,400	2050	—	—	34,000	TUBE	SCRUB	6500	12,000	26,500	DRY	P.C.-OIL	1	76,200	9.2	80	1	123,000	9.4	330	1 1	6000 6000	3600	0.49 50	8250 —	AIR AIR
MIDLAND	1250	825	1	300,000	3510	4950	—	27,800	49,900	TUBE	—	4900	15,200	27,000	SLAG	P.C.	2	50,000	10.5		2	85,000	12.5		1	7500	3600	400	—	AIR

[1]Reheat at 415 lb. to 850 deg. F. h.p. turbine 22,500 kw. 3600 r.p.m., L.P. turbine 45,000 kw., 1800 r.p.m.

[2]Reheat at 400 lb. to 825 deg. F. 2 standard, 1 reheat boiler. Reheat capacity 1,063,000 lb. per hr. at 440 lb. pres.

[3]Includes 200 sq. ft. of exposed risers but not 860 sq. ft. of stoker cooling tubes in water wall surface.

[4]Superheater surface of 15,518 on first boiler includes 1530 sq. ft. of radiant superheater in one half of the double furnace.

[5]Gas burned over stoker. Present operation at 275 lb.

[6]Gas burned over stoker.

[7]Also has three turbo-blowers and two industrial evaporators. The latter supply 150 lb. steam.

Prediction of future development is out of the question so that only a general summation of probable trends in somewhat trite terms is possible.

Recent developments indicate that the reheat cycle will continue supreme for ultimate heat economy and base load operation, temperatures will undoubtedly creep up toward 1000 deg. F. as a limit but the pressure range is more indefinite. Whether the slight gain in efficiency of 2400 over 1400 lb. will be justified by commercial economy remains to be seen. For topping plants 1200-1400 lb., 850 to 950 deg. F. will continue, the exact conditions being dictated largely by the old equipment to be topped. At present 850 lb., 850 deg. F. offers good commercial possibilities for smaller condensing plants but it is probable that as moisture conditions in the turbine exhaust become less critical and equipment becomes standardized this group will gradually merge into the 1200-1400 lb., 850-950 deg. F. group as the moderate pressure reheat cycle did a few years ago.

For the industrial plant, 650 lb., 750 deg. and 450 lb., 650-700 deg. will probably be the popular ranges, for, like topping plants, the initial conditions are usually determined by factors other than power generation, and the Efficiency is set by proper interpreting of process needs. The big field for improvement still lies in closer industrial and utility cooperation.

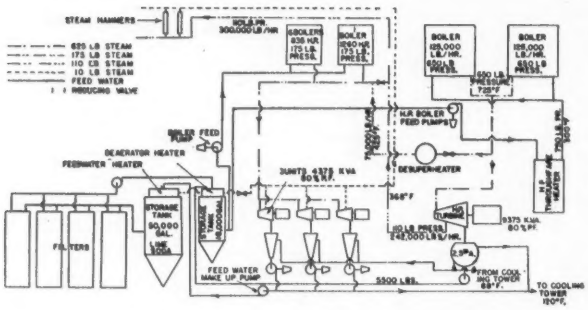


Fig. 5. Chevrolet-Forge uses a modified top with most of the steam flow to the high pressure turbine extracted for use in older low pressure equipment. All feedwater is heated with extracted steam. This same arrangement, with additional bleed points, will be used in a central station now under construction of 430,000 lb. per hr. of 1250 lb. 900 deg. F. steam to a new 30,000-kw. turbine, some 210,000 will be extracted at 250 lb. for an old 30,000-kw. turbine. Condensate from both old and new units will be heated by steam extracted from the low pressure steges of the new turbine

to the hotwell pump mounted on the same shaft with the boiler feed pump. Alternating current motor driven auxiliaries were almost standard at one time, but steam drive is now playing a larger part especially in top plants. At Seward, Fig. 4, an addition to an older station, steam drive is used extensively and but one stage of extraction used. High pressure extraction would interfere with heat recovery by the economizer as mentioned earlier.

Among the industrials, the Carnegie-Illinois South Works plant power generation follows the conventional regenerative cycle with one deaerating heater and two extraction heaters in the cycle. The plant does, however, provide for three additional turbo-blowers and an industrial evaporator to supply medium pressure steam for general use around the mill. The Wilson & Co. Albert Lea plant uses comparatively high throttle pressures, and a flexible combination of turbine sizes to allow balancing steam and electric loads at maximum efficiency. Turbines are bled at two points and exhaust at 10 lb. to process. The new Charleston plant of the West Virginia Pulp & Paper Co. is described in detail later in the issue. Dow Chemical is a straight 1200 lb. top plant, an important step in adapting high pressure tops to industrial service.

Industrial plant heat balance problems are infinitely more troublesome than those of the central station. Where the latter deals with one variable, the electric load which is more or less controllable by shifting loads between stations, the industrial engineer must deal with two and often more variables which are beyond his control.

With utility rates as they are today, consideration of an industrial plant almost presupposes a sizeable process steam load. Few industries are fortunate enough to have the steam and electric loads coincide and many of them are faced with the further problem of supplying steam at two or more pressures. The ideal arrangement is of course close cooperation with utilities which allows generation of electric power up to the needs of the process with excess or deficiencies absorbed or made up by the utility system.

Unfortunately such close cooperation exists in few, very few cases. The Hiram Walker Distillery in Peoria (p. 398, Sept. 1934) is an outstanding example. In some cases high pressure steam is purchased from the utility system as the Kingham Co. and Eli Lily Co. in Indianapolis and more recently the new Houston Mill of the Champion Pulp & Fibre Co. where high pressure steam purchased from Deepwater Station made it possible to eliminate all but byproduct fuel boilers.

In the majority of cases, however, the industrial engineer must solve his problems unaided. Even though tied in with the utility system, the desired degree of flexibility often demands a condenser. This practice was well illustrated by three plants, details of which were made available this year although the plants were listed in last year's review.

At the Chevrolet-Forge plant (see page 516, Sept. 1937) 650 lb. boilers supply a new turbine from which most of the steam is extracted at 110 lb. to supply old low pressure prime movers, process and feedheating. Steam to the condenser is normally kept at the minimum necessary to cool the blades. This arrangement provides flexibility and safety. It is perhaps difficult to

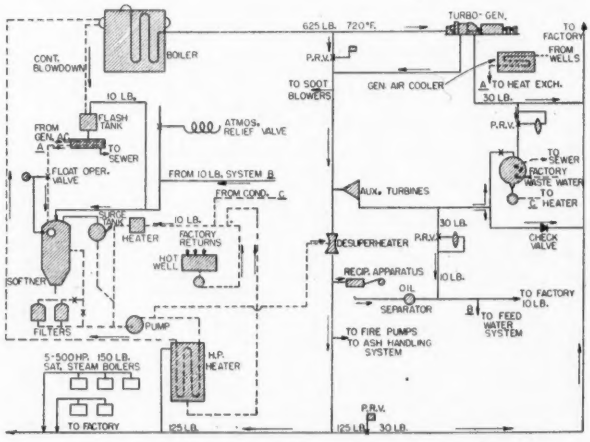


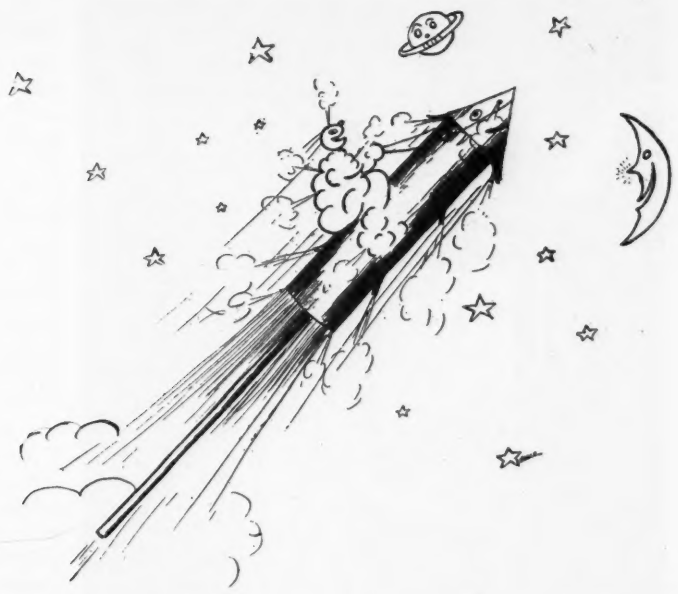
Fig. 6. The single boiler, single turbine plant of the Post Prod. Div. of General Foods makes effective use of extracted and exhaust steam to supply power and heating steam at three pressures

classify although it has been referred to as a top-condensing plant and as such has wide application to the central station as well as the industrial field as mentioned in connection with Fig. 5.

At the Post Products plant Fig. 6, (see also p. 644, November 1937) process or heating steam is supplied at three pressures by a 650 lb. boiler. A small condenser on the 30 lb. system supplies flexibility and takes care of differences between the summer and winter low pressure load. Power is both generated and purchased.

The Monarch mill of the Allied Paper Co. at Kalamazoo (see p. 144, March 1937) generates all power in a condensing extraction turbine. Here, however, is a power engineer's dream come true. Not only is condenser water available under sufficient head to dispense with circulating water pumps but the process demands for warm water are such that the condenser heat losses are reclaimed a major portion of the year.

If an engineer knew the exact operating conditions for the life of the plant his problem would be comparatively easy. Unfortunately, this is impossible and the present unsettled state of equipment design makes an entirely satisfactory solution of the power problem difficult.



STEAM ON THE UP and UP

So carefully have engineers designed and operated their high-pressure, high-temperature steam generating equipment that the peaks of progress in the industry have leveled off with time only to gain footing for the next higher climb

AS A MEDIUM for converting the heat of fuel into mechanical and electrical power, nothing so far seems in any way likely to supplant water and its higher temperature form, steam. Mercury has had its trials, and experiments are still in progress, but for numerous reasons engineers generally have given it a cold shoulder in the design of new plants. Dowtherm, while showing some theoretical advantages, has not been applied for power purposes but is being used to some extent in place of steam for process heating where the temperatures required range from 400 to 700 deg. F.

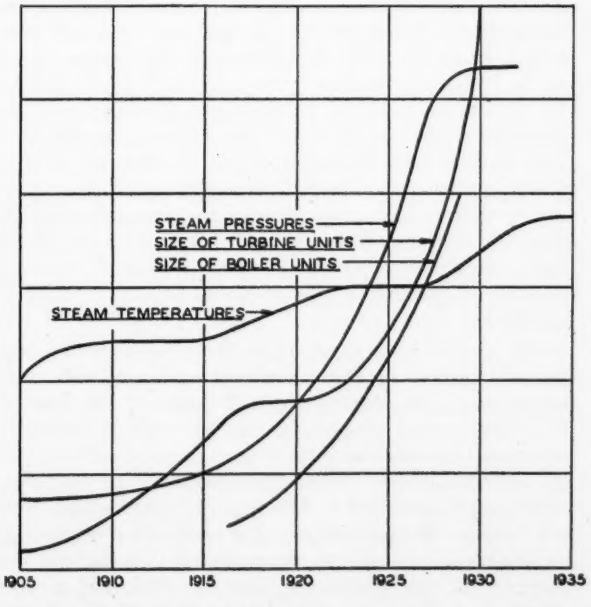


Fig. 1. Graphic representation of changing conditions in power plant practice. The maximum in service being: Turbine size, 208,000 kw.; steam pressure, curve ends at 1400 lb., later installation 1800 lb. and being built 2500 lb.; boiler size, 1,000,000 lb. per hr. rating; steam temperature, 925 deg. with 1000 deg. under experiment

With the steadily increasing load placed upon power plants, engineers have turned, in a large number of instances, to the superposed arrangement of equipment as the best way to increase the plant capacity. In the boiler room, this has meant the installation of steam generators capable of maintaining higher pressures and, usually, higher temperatures. These units in many cases have replaced old low pressure equipment without much change in building construction which has necessitated many special designs capable of generating as high as 750,000 to 1,000,000 lb. of steam per hour at pressures up to 2500 lb. per sq. in. and temperatures of 940 deg. F.

These new boilers are not fundamentally different from what have been used in former years but differ in arrangement of tubes, drums, baffles and dampers. Details of manufacture and choice of metals have had to undergo changes and the more exacting operating conditions have necessitated the development of control equipment formerly not available.

Fisk Station boilers installed during the year are examples of typical changes that are going on in the arrangement of heating surfaces. Each of these two

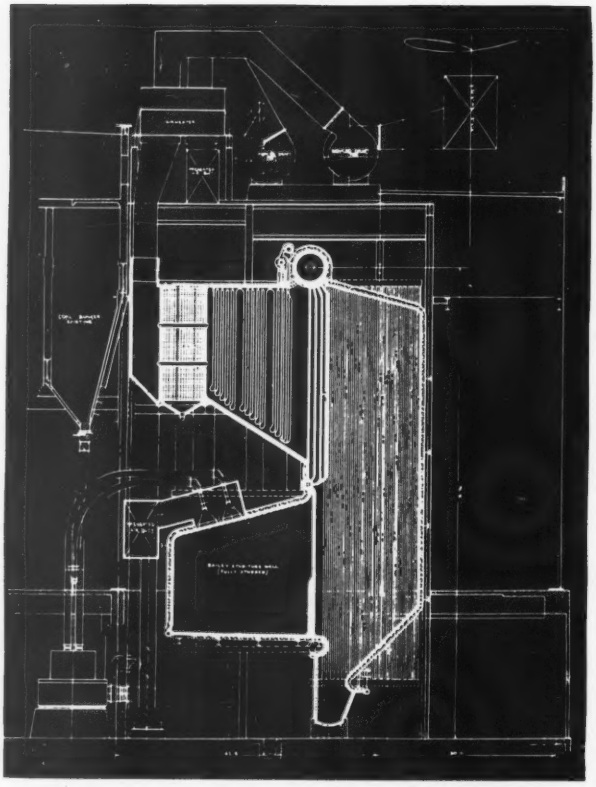


Fig. 2. Cross section of boiler planned for Twin Branch Station to be rated at 550,000 lb. per hr., 2500 lb. pressure and 940 deg. F.

boilers has a continuous rating of 375,000 lb. of steam per hr. at 1275 lb. gage pressure and 910 deg. F. temperature. They are of the sectional water tube type with two stage water cooled furnaces, (stud tube, bare tube and flat block); continuous tube steaming economizers; continuous tube counterflow superheaters; and welded vertical tubular air heaters. Furnace width is 23 ft., depth 30 ft., average height in primary section is 18 ft., in secondary section, 28 ft. Heat liberation is 31,600 B.t.u. per cu. ft. per hr. Slag is removed continuously from the primary furnace, through two holes in the floor, while dry ash is removed from secondary furnace. The primary section of each furnace is fired by pulverized coal through four multiple intertube burners with an electrically lighted illuminating gas ignition system.

Another example of modern design is the Logan boiler, now in operation as a single unit serving a topping turbine. It is of the 6-drum, double-V type using tangent tube construction for the water walls, tangentially fired with pulverized coal, ash being removed in dry form. It is rated at 1,000,000 lb. of steam per hr. 1325 lb. pressure and 925 deg. F. temperature. Superheater temperature is regulated by a bypass, with a tolerance of plus or minus 10 deg. Superheaters are of the convection type, vertically supported, economizers are of the return bend tube type.

At Windsor, two boilers, each rated at 750,000 lb. per hr., 1350 lb. pressure, 925 deg. F., radically different in design, serve one high pressure turbine in a superposed addition to the plant. One of these boilers is a three-drum type employing tangential firing, very conservative heat release rates, a convection type superheater and standard arrangement of economizer and air heater. The furnace bottom is designed for continuous slag removal.

Designed within the same space limits, the second boiler at Windsor uses a three-drum, center-split furnace arrangement with a very limited straight tube section. The two halves of the split furnace are independently fired, one-half being equipped with a radiant-type superheater in the wall section. The net effect of this is not only to give maximum ease of control of superheat over the entire range desired and within the limits desired but what is equally important, to give a design that naturally has a larger than normal amount of radiant heat absorbing surface.

At Twin Branch plans are being carried out for the building of an extension which will employ 2500 lb. pressure steam at 940 deg. F. temperature in a straight regenerative-reheat cycle. This is the first application in America of steam pressure at this level and its operating results will be watched with extreme interest. Due to the small difference in weight between steam and water at 2500 lb. pressure, the main problem in the design was the securing of proper circulation. The design includes very little convection surface in the boiler proper, except a few rows of tubes immediately in front of the superheater. It will have a rating of 550,000 lb. of steam per hr. at a superheater outlet pressure of 2500 lb. and a temperature of 940 deg. F. The integral reheater is designed to handle 450,000 lb. of steam per hr. at a pressure of 450 lb. and will reheat to a range from 850 to 900 deg. F. Practically all of the heat transfer surface in the furnace and boiler is vertical. Only convection surface will be used for the superheater with a bypass for temperature control.

Another outstanding boiler and furnace design, also serving a superposed turbine, that is now in operation, is installed in the Cedar Rapids plant. Here steam is generated at 700 lb., 765 deg. F. total temperature, the boiler rating being 300,000 lb. per hr. The unit may be classed as a straight tube, 3-pass boiler, having 13,389 sq. ft. of heating surface. The superheater has 4533 sq. ft. of surface and has an interdeck location with the elements welded to headers. The boiler is served by a water-cooled underfeed stoker and the furnace is completely water cooled on all sides and in addition a double center wall of bare tubes divides the furnace vertically into two sections. The coal used here has a low fusing temperature ash and these cooling walls have made possible a combustion rate of 55 lb. per sq. ft. without ill effects.

It is noteworthy that the first Velox boiler unit to be installed in the United States is now in trial operation in the Marcus Hook Refinery of the Sun Oil Co. The normal evaporation of this unit is 50,000 lb. of steam per hr., absolute steam pressure 450 lb. per sq. in., total steam temperature 940 deg. F., feedwater inlet temperature 140 to 212 deg. F., and the fuels used are bunker oil and refinery gas used either separately or combined. It will be remembered that the distinct features of this boiler are that the fuel and air are supplied under pressure giving unusually high gas velocities with high heat transfer, high steam making capacity and extremely sensitive control.

At the plant of the Dow Chemical Co., another

industrial, the steam generator going into service has a capacity of 300,000 lb. per hr. at 1400 lb. pressure, 850 deg. F. total temperature. A view of the cross section, Fig. 4, would indicate that most of the heat transfer takes place in the furnace walls. Pulverized coal is used here and the unit has a slagging furnace of the continuous run off type.

Steam generators are subjected to three types of loads, i.e., continuous at normal rating, varying between high and low output, and intermittent off and on as in standby service. Each of these types of loads has an influence all its own on the temperature variation in the furnace and consequently on the slagging and clinker formation characteristics of the furnace. The space available for the boiler furnace must be considered in the choice of burning equipment first, because some types of equipment require more space per pound of fuel handled than others and second because the rating of the boiler depends upon the volume and design of the furnace. Fly ash in some cities must be kept within limits difficult to meet without careful selection of burning equipment, furnace design, provision of settling spaces in the boiler setting or special cinder and fly ash catching equipment. In the design of many plants, this difficulty alone has been a deciding factor between stokers and pulverized coal burners. The use of slag tap furnaces and coal having ash with a low temperature fusing point have done much to relieve this annoying problem with pulverized fuel.

Final steam temperature may be so high, or load conditions require, that radiant type superheater tubes be so located in the furnace walls as to absorb some of the heat directly from the furnace. The required steam temperature is therefore a factor to be considered in the design of the furnace walls.

Boiler Fuels

Engineers are no longer content with coals as they come from the mines. The fact is coal burning equipment, developed for power plants, has been using the lowest grade marketable product of mines for economic reasons. As mines become worked out, however, the less desirable mines must be opened and it may be expected that the coals obtainable will continually become of lower quality. So coal users are demanding that something be done about it, and coal producers are endeavoring to work out methods by which the demands of the industry may be met economically. So it has come about that the quality of coals used in many power plants has been improved by careful screening, washing, sizing and dedusting. By these means it has been found practicable to reduce the ash content of the coal, at the same time increasing the heat value per pound of coal, improve the ash fusion characteristics and enable the operator to secure higher efficiency.

Such improvements in coal quality have been welcomed by engineers, particularly those in charge of plants with the older types of stokers, since the decreasing quality of untreated coal and the increasing loads to which the plants have generally been subjected have presented extremely difficult problems.

In the paper industry a new by-product fuel, which gives promise of considerable application in that field, has put in its appearance. This fuel is the resinous material carried away in the so-called black liquor obtained in the process of making pulp. Progress is also being made in the use of city garbage as fuel for the generation of electricity, particularly in municipally owned utility plants.

The latest stoker development of particular important to power plant operators was the provision for water cooling of the fuel bed of underfeed stokers which has now proved its value in several installations. Among the smaller stokers, improvements have been made in the construction of detail parts and control equipment in connection with both underfeed and sprinkling type stokers.

Fuel and ash handling methods have not changed to any great extent during several years. Bucket and belt conveyors still prevail for coal handling in power plants with an occasional installation of Redler conveyors and invariably air transport from pulverizers to burners. During the past year, however, a rubber conveyor of the closed type with circular cross section has been put into service. It consists essentially of two semicircular strips of rubber, each reinforced by a chain, to give it strength, and with the contacting edges tongued and grooved so that the conveyor resembles

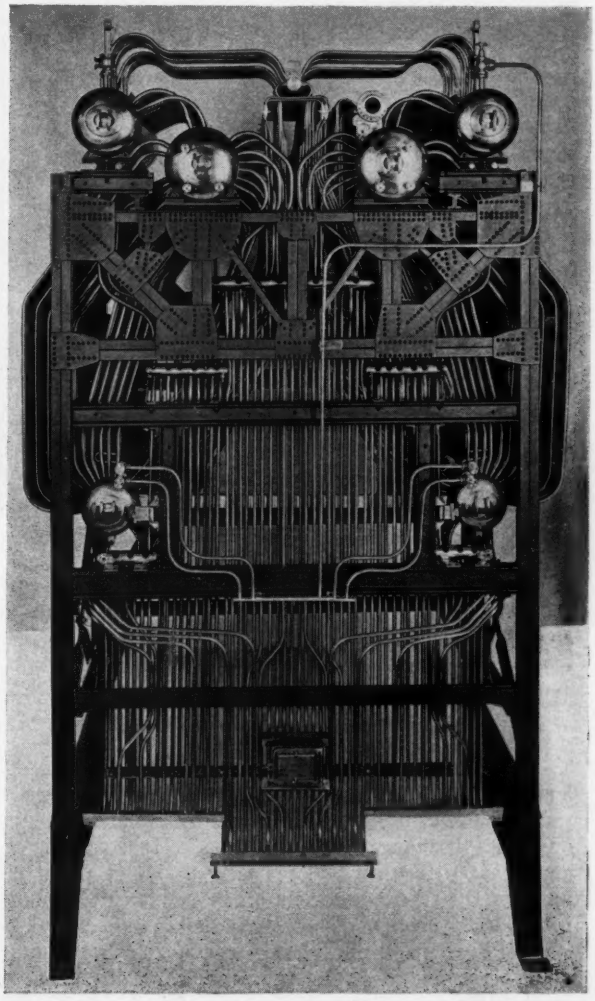


Fig. 3. Arrangement of tubes and drums of the recently installed Conners Creek boiler is shown by this photograph of a model built by E. C. Kiethley, Detroit representative of The Superheater Co. and presented as a gift to the Detroit Edison Co.

a rubber pipe, the diameters ranging from 2 to 12 in. One side of the conveyor is provided with rubber disks which prevent the flow of the material along the conveyor. At feeding and discharge points the conveyor is opened and closed by passing over specially designed pulleys. The two halves of the conveyor are held together by the form of joint and giving the tube a twist. These conveyors run over sheaves and may carry the coal in any direction, horizontally, vertically or around corners.

Manufactured equipment is also now available for conveying coal horizontally or at some elevation from coal bins to stoker hoppers. This equipment is finding an application in medium and small sized boiler plants serving office buildings, apartment houses, institutions and factories.

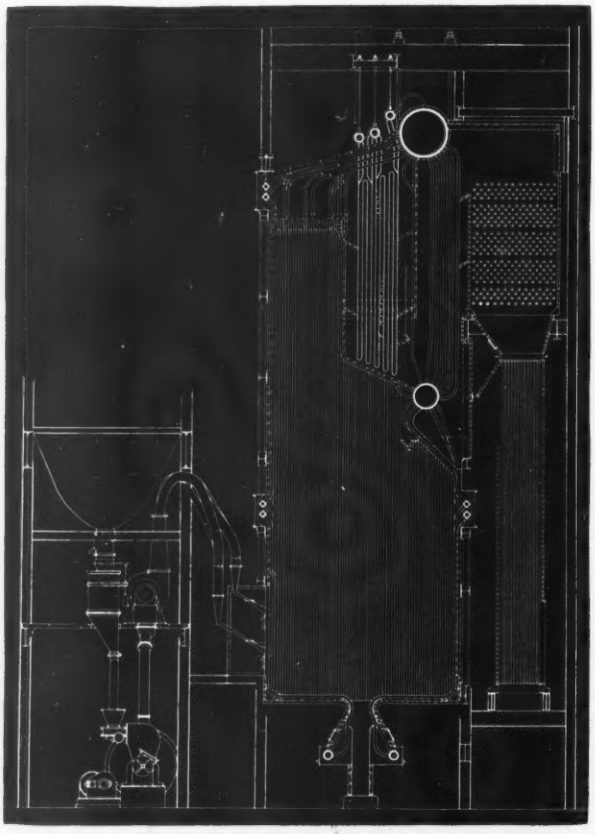


Fig. 4. Cross section of the Dow Chemical Co. boiler

Flue Gas Problems

Boiler plant engineers are still faced with the problem of preventing their plants from being a nuisance in the community because of the soot, fly ash and sulphurous gases discharged from the stacks. It is well recognized that with a furnace properly designed and operated for the fuel being used, black smoke can be eliminated. This problem is being handled in many cities by control over the design of furnaces and burning equipment being installed, and the conducting of classes on combustion among those in charge of boiler operation.

Fly ash, however, is quite another problem and it is not confined wholly to pulverized fuel burning equipment, as many have been inclined to think. Design of the furnace and boiler tube arrangement have much to do with the amount of fly ash discharged to the atmosphere and along with these factors, now recognized as of equal importance, are the burning characteristics of the coal. In spite of all effort to correct the evil at its source, engineers have found it necessary in large plants operated at high ratings to provide special equipment designed for no other purpose than to remove cinders and fly ash. Such modern equipment includes specially designed fans, cyclone collectors, washing sprays, and electrostatic precipitators, the choice of equipment depending to a large extent upon the degree of removal required.

As yet no satisfactory method of removing sulphurous fumes has come into use in power plants. Engineers have answered this complaint by using coal with less sulphur content.

It is interesting to note, in connection with fly ash removal, that the U. S. Bureau of Mines has developed a supersound wave method of solving the smelter-fume problem that offers possibilities in helping to curb the smoke nuisance in cities although as yet no attempt along this line has been reported.

Another solution to the smoke and fly ash problem which may prove to have considerable application is a new process developed for recovering CO_2 at low concentrations. This process utilizes ammonia gas to speed up chemical reactions in giant absorption towers where flue gas is passed through a lye solution for the recovery of the CO_2. By this method dry ice is secured as a by-product of a power plant.

Feedwater Treatment and Heating

Methods of treating boiler feedwater in power plants have not undergone any noteworthy changes announced during the past year. The importance of clean boilers and scale free heating surfaces grows with each boost in pressure, temperature and heat transfer rating to which boilers are subjected and year by year more power plant managers are recognizing that the water treatment problem calls for the services of specialists in this line. Results secured in boiler plants from water treatment both inside and outside the boiler are growing more satisfactory as evidenced by longer periods of service, fewer tube replacements and less frequent necessity for washing turbine blades. During recent years the importance of treating for silica has become recognized and a number of proprietary treatments have been developed and are being used throughout the country. Which of these will prove most satisfactory and economical is a matter of conjecture at the present time.

Removal of oxygen from feedwater is recognized as essential to prevent corrosion and the most common method is by means of the deaerating heater which may be one or more of the series of bleed heaters used commonly in the regenerative heat cycle in high pressure plants, or as a low pressure heater supplied with exhaust steam from auxiliary equipment.

Common practice in high pressure plants would indicate the necessity of using distilled water from evaporators for make-up purposes; it has been found advisable to treat the raw water going to evaporators in order to secure best operation.

'ROUND and 'ROUND SHE GOES

And as yet nobody has been able to tell just yet where improvements in prime movers will stop. Pressures, temperatures, speeds, controls, cycles —all have undergone changes for more economical operation, and the end is not in sight.

IN THE FIELD of turbine development, features of outstanding interest, as in the boiler plants, are principally those in connection with superposed plants, for it is in connection with these higher pressures and temperatures that the newer designs of equipment are being tried out. As has been pointed out, the most economical method of adding to the capacity of comparatively recently built plants has been by employing superposed equipment and this year has seen much of this equipment go into service in public utility plants with a number of plants yet to be built, the plans for which have already been made. Some progress along this line has been made in the industrial field and a few noteworthy examples are to be found leading the way.

One large turbine manufacturer has reported that approximately one-third of the units of 7500 kw. and above sold during the past year will operate noncondensing, about the same number at temperatures in excess of 850 deg. F., and about half the turbines in this range of capacity operate at pressures in excess of 650 lb. per sq. in. Another marked tendency is toward the higher speed of 3600 r.p.m. as compared with 1800 r.p.m. for the large machines up to very recent years. For 60 cycle generators, the highest possible turbine speed is 3600 r.p.m. By operating at this maximum speed, the overall size of the unit and the weight of the individual parts are considerably reduced as compared to 1800 r.p.m. machines of the same capacity.

The high operating temperatures have necessitated the use of special heat resisting materials, such as carbon molybdenum steel, for parts subjected to the high temperature. Such metals must possess high tensile strength and low creep properties at the elevated temperatures to which they are subjected. Alinement difficulties that accompany expansion of turbine parts due to temperature changes have been overcome by careful design, according to one manufacturer, so that expansions are guided in such a way that there is practically no change in the alinement when starting up, shutting down, or when operating the turbine.

With the increasing loads and the more exacting operating condition being placed on turbines, various methods of modernizing existing units are being given more attention than formerly. Some plants with comparatively modern designs have resorted to simple repair and replacement of worn parts to improve efficiencies. This may necessitate providing new nozzles, blades and seals, the building up of eroded parts and a general overhaul. By this course higher operating efficiencies than obtained from the original unit cannot be expected, but it has the advantage of less capital outlay and usually less time to get back in service.

Another possibility in modernization, advantage of which has been taken in some plants, consists of rebuilding idle 25 cycle units for 60 cycle operation. In this case the work on the turbine may vary from a simple change of the governor gears to a complete rebuilding; the generator of course must be rebuilt.

Modernizing by means of the superposed plant, however, offers the greatest possibilities where the existing plant is of fairly recent installation and the exhaust from the high pressure unit can be used to operate the turbine now installed. This method makes possible the installation of a strictly modern high efficiency turbine, provides 30 to 100 per cent increase in plant capacity without adding to the condenser load, and almost invariably requires modernization of the boiler room without the necessary expensive addition to the building.

Other plants have taken advantage of the oppor-

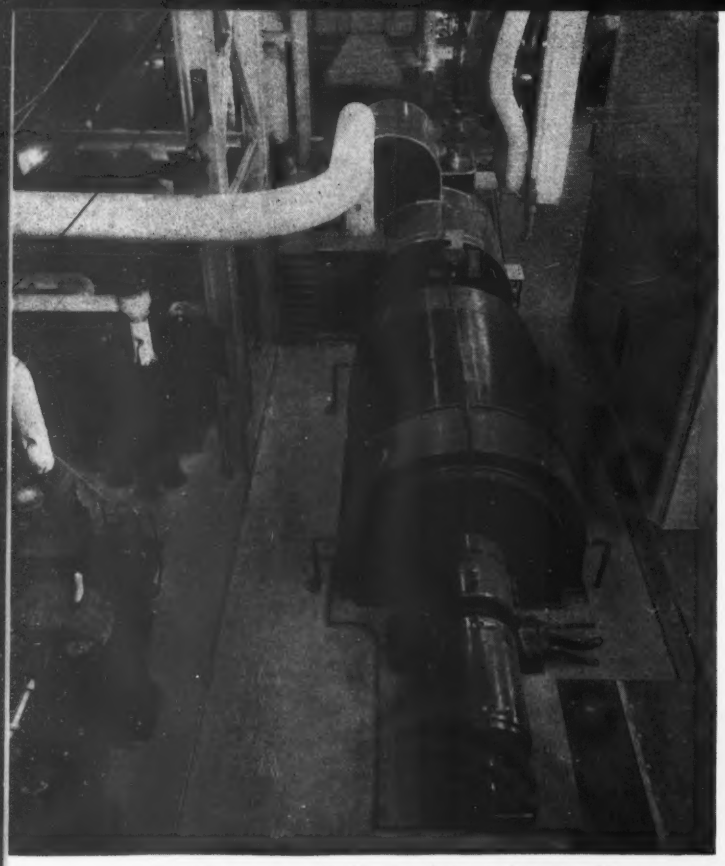


Fig. 1. Topping turbine installed in Fisk Station, Chicago

tunity to increase their heat economy by the use of the new steam cycles now available, namely increases in pressure, temperature, vacuum and the application of regenerative feed heating. These cyclic changes are of value in increasing economy, perhaps advancing a turbine from the standby service to an economical base load unit, but they do not add to capacity.

Typical of advanced turbine practice is the work being carried out by the American Gas & Electric Co. at Logan, Windsor and Twin Branch. A feature of extreme interest about the Logan 50,000-kv-a., 1250 lb. turbine is the provision of inner and outer casings, by which arrangement the exhaust steam at about 200 lb. pressure surrounds the inner casing so that the outer casing is subjected to only about 200 lb. pressure.

At the Windsor plant is the largest topping turbine yet installed, its capacity being 60,000 kw. at 90 per cent power factor. It operates at 3600 r.p.m. The throttle pressure is 1250 lb. per sq. in. at 925 deg. F. temperature, while the exhaust pressure is 235 lb. gage. This turbine is also of the double casing design. In some other details, however, this turbine differs from that at Logan, simplifying the piping problems both for construction and operation. A full set of supervisory control equipment is provided at Windsor.

For the 2500 lb. pressure plant being built at Twin Branch, the turbine will be of the double shell design, similar to those at Logan and Windsor, and will have a single stop valve and six control valves with 18 stages of expansion. It will be rated at 22,500 kw., 2300 lb. abs. pressure at the throttle at a temperature of 940 deg. F. Exhaust pressure will be 470 lb. abs. and the speed will be 3600 r.p.m. Two stages of bleeding will be provided. The low-pressure turbine will have 17 stages of expansion with 4 points for bleeding. It will be rated at 45,000 kw. running at 1800 r.p.m., operating at a normal pressure of 415 lb. abs. and 850 to 900 deg. F.

Unique among the many turbine-generator installations is a 53,000-kw. unit in the Waterside Station. This turbine was designed for 3600 r.p.m. and steam conditions of 1200 lb. per sq. in. gage pressure, 900 deg F. total temperature and exhaust pressure of 200 lb. per sq. in. gage. The outstanding feature is a feed-heating turbine connected in tandem to the main unit and arranged to receive steam at the main exhaust pressure and bleed into 60 lb. and 5 lb. per sq. in. gage heaters.

One problem encountered in a superposed application is that of heating the feedwater to the economical temperature for the new steam conditions. Many of the older machines for which superposition is desirable do not have suitable openings for extraction of steam for feedwater heating. Extensive rebuilding and excessive cost are involved in providing such openings. The feed-heating turbine solves this problem.

For a paper mill drive soon to be installed in the Middle West, a turbine having special control is under

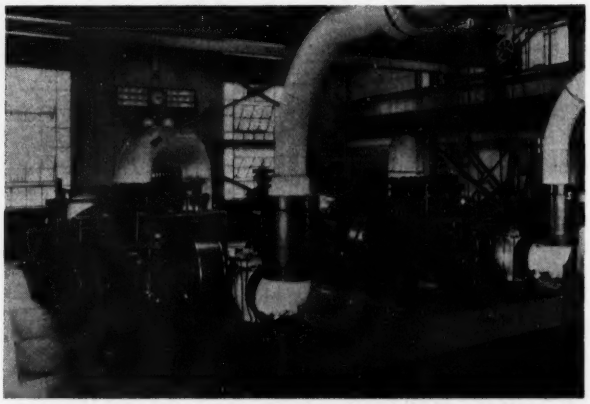


Fig. 2. Recently completed superposed turbine installation in Rochester, N. Y.

construction. A practically isosynchronous operation is required, and at the same time, a wide range of speed with facilities for adjustment throughout this range during operation is necessary to satisfy the requirements of various grades of products. A special governing mechanism will be employed which will give a speed range of 30 to 1.

Some features of the 30,000-kw. topping turbine recently put in service at Fisk Station should not be overlooked. There is a possibility that at some time in the future it may be found desirable to change the speed of the turbine from 1500 r.p.m. to 1800 r.p.m. in order to replace the present 25-cycle generator with a 60-cycle generator. The design of the turbine and governing mechanism is such as to accomplish this change in speed. Another feature is that the turbine governor and desuperheater control are tied together for, with 750,000 to 825,000 lb. of steam flowing per hour, extremely quick operation of the bypass valve must be accomplished in case the load suddenly changes.

At the plant of the Rochester Gas & Electric Co. the second unit in its topping program has now been installed, thus completing this part of the construction program. This unit is a duplicate of the first turbine, having a capacity of 6000 kw., running at 3600 r.p.m. and operating non-condensing, steam pressure at the

throttle being 650 lb. gage at 750 deg. F. and exhausting at 210 lb., 530 deg. F.

Along with increase in steam pressure and temperature, and greater capacities and higher speeds of turbines has come the necessity for extremely close supervision of operation, so close in fact that manual supervision of certain conditions is far from adequate and best practice is now demanding the installation of instruments that will keep the attendant informed on such conditions as eccentricity, vibration amplitude, expansion and interference in addition to the pressure, speed and temperature instruments.

Steam Engines

Steam engine practice has not changed fundamentally in several years. In capacities of 1000 kw. and less, it is generally recognized that the steam economy of modern engines is greater than turbines and many of both four-valve and uniflow engines are going into plants serving institutions and industries. As a rule these engines are run non-condensing with the exhaust steam used for space heating or industrial purposes.

Diesels Strengthen Position

In the engineering field more than any other, the final success comes to that equipment that can show the highest economy. Years of development and use in the field may be necessary to iron out the failures

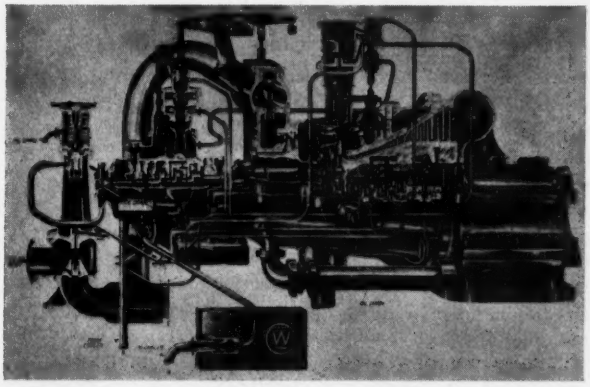


Fig. 3. Section through a 5000-kw. condensing single extraction turbine installed in the Detroit plant of the U. S. Products, Inc. Inlet steam pressure 400 lb. at 600 deg. F., exhaust at 28½ in. hg., extraction at 160 lb.

of detail parts but with sound fundamental principles back of the equipment a place in industry will be found where this equipment surpasses all others. The Diesel engine has now reached a degree of perfection where engineers can count definitely on its reliability, its length of life, its economy of operation and its availability under proper operating care. The Diesel has "gone to town" in a big way and it may be expected to stay there for a long time.

Outstanding among the advancements of the past year has been the successful operation of an internal combustion engine designed to use either oil or gas as fuel. This design of engine meets the need for a prime mover that can take advantage of low gas rates yet be provided with standby fuel at reasonable cost to take care of emergency conditions and give desired independence from a single fuel supply. One unit, in operation at Lubbock, Texas, is built as a Diesel engine that may be operated on either oil or gas on the 2 cycle Diesel principle.

Automatic Controls

Regulations governing the installation of Diesel engines on some passenger ships has given impetus to the development of certain automatic controls which are now available for stationary service and their use has opened up fields of application heretofore closed to Diesel engines. The requirements are that the generator unit must be so arranged that if the main source of power aboard the ship fails, the auxiliary Diesel driven generator will start automatically within a predetermined time and furnish emergency lighting and power for the ship's communication equipment. Similar service is required in many public buildings, schools, hospitals and penal institutions. Water pumping systems and disposal plants require pumps that will start and stop automatically. Likewise refrigeration and cold storage plants require automatically controlled compressor drives to regulate temperatures and pressures.

Such automatic controls are now being applied to high speed Diesel engines. Most of these engines employ an automatic type battery operated electric starter which is kept in a charged condition by means of a generator mounted integrally with the engine. Automatic starting may be accomplished within an elapsed time of 10 sec.

An interesting installation of Diesels for standby service is in the Clarksburg plant of the Pittsburgh Plate Glass Co. where the load may be picked up automatically in 15 to 30 sec. The engine used here is adapted for the use of natural gas.

Block plants serving buildings with power and steam have been in use for many years in congested city districts but the first Diesel block plant to serve important buildings with light and power in the city of New York went into service during the past year. Aside from the unusual electric service of these Diesel engines, a novel feature is the cooling water system in which the jacket water is passed in a closed system through space-heating radiators throughout the buildings. The exhaust gases are discharged through silencers to the fireboxes of low pressure boilers in one of the buildings and thus aid in the generation of steam.

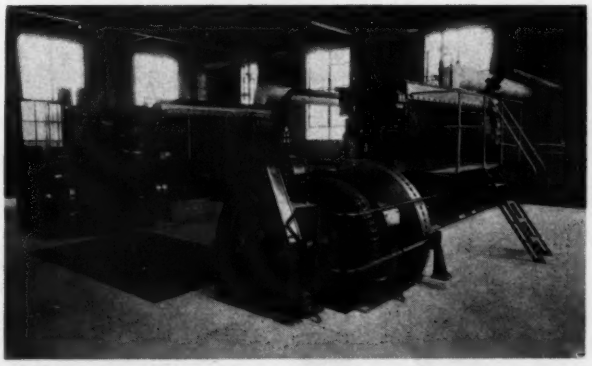


Fig. 4. Two 250-kw. Diesel-generating units in the Connersville, Ind., municipal plant. They run at 400 r.p.m., use filtered air, exhaust through silencers, and are cooled by softened water in a closed circulating system

ELECTRIC GENERATORS

AS POINTED OUT in the general summary of electrical developments in another article in this issue, progress in electric generator practice during the year was marked by a more general use of hydrogen as a cooling medium in large machines and in a greater tendency towards the use of 360 r.p.m. speeds for units with capacities as high as 50,000 kw. The 50,000-kw. unit referred to here is, of course, the 50,000-kw. "top" unit installed this year at Waterside Station in New York. This, like the 40,000-kw. generator placed in operation in the Logan Station is a hydrogen cooled machine. In addition to these a number of other 3600 r.p.m. units, ranging in size from 25,000 to 50,000 kw. are being installed or on order. On the basis of the present status of hydrogen cooling for 3600 r.p.m. machines, generators with ratings up to at least 75,000 kv-a. can be built but this limit will undoubtedly be extended considerably by investigation and researches now under way.

Both of these developments, the tendency toward the use of 3600 r.p.m. and the use of hydrogen, are in the direction of smaller, more compact units. Modern electric generators are already highly efficient machines, the large units running as high as 98.7 per cent at rated loads.

Except for these developments in cooling practice and in the tendency toward higher speeds, generator practice is fairly standard and has undergone no fundamental change during the year. There has been much greater change in other parts of the electrical system than in the generator itself. In the design of the bus structure and in the type and arrangement of circuit breakers, for example, the change is much more noticeable. The reason for this perhaps is the fact that there have been very few new bus systems installed in power stations during the past five years so that now when new buses or extensions to existing buses become necessary the full impact of five years' of accumulated knowledge and development is impressed upon us.

While bus design can under no circumstances be considered standard, progress in bus design this year is exemplified by the new, totally enclosed bus installed at Waterside Station in New York in connection with the 50,000-kw. "top" unit referred to above. This bus is a radical departure from even the most modern bus of a few years ago. It consists of a fabricated steel supporting structure on which are mounted the disconnecting switches and the bus insulator assemblies which carry the buses. Each phase of the main and auxiliary buses is enclosed in a split steel cylindrical housing, 16 in. in diam. with the halves bolted together.

If bus practice has undergone developments, the same is true of circuit breaker practice, in fact there are few branches of the electrical system where development has been as revolutionary as in the circuit breaker field. The development of the Deion and oil blast principle in large size breakers is well known. Now these principles are being incorporated in small breakers as well, and as a result of this and other improvements the trend in indoor circuit breaker practice is definitely toward the use of all enclosed, so-called vertical lift type of switchgear.

With reference to circuit breaker operation on high voltage transmission practice, the ultra-high speed reclosing circuit breakers described by Philip Sporn at the A. I. E. E. Meeting in New York in January are of interest. These breakers, performing a complete cycle in approximately 20 cycles on a 60 cycle system, make it possible to clear the line of a fault and restore service before the synchronous load falls out of step. This single illustration perhaps more than anything else is indicative of the great advances made in circuit breaker performance in the last few years. It used to be that when a fault occurred and a breaker opened, it remained open for two minutes. Now under the same conditions the breaker opens and closes in 1/3 of a second.

There has been no increase in voltage used in transmission line practice during the year, the 267-kv. Boulder Dam line being the highest in use. But, as pointed out in the general review in the preceding article, the upper limit of underground cable transmission voltage was extended a hundred kilovolts by the installation of a 220-kv. underground cable as a part of the new ring bus around the metropolitan area of Paris, France. Since 1932 an experimental section of 220-kv. Pirelli cable 600 meters long had been in service at Cislago, Italy, and the success of this installation led to the adoption of the 220 kv. cable for the Paris bus. The cable used is a paper wound cable filled with oil distilled from a raw petroleum of Russian origin. All three single conductor cables are laid in a single concrete trough in contact with each other.

An interesting factor in transmission and distribution practice is the growing importance of capacitors. Shunt capacitors, for example, have come into general use as a flexible and economical means of improving the power factor and maintaining proper voltage on

TAKE GAS

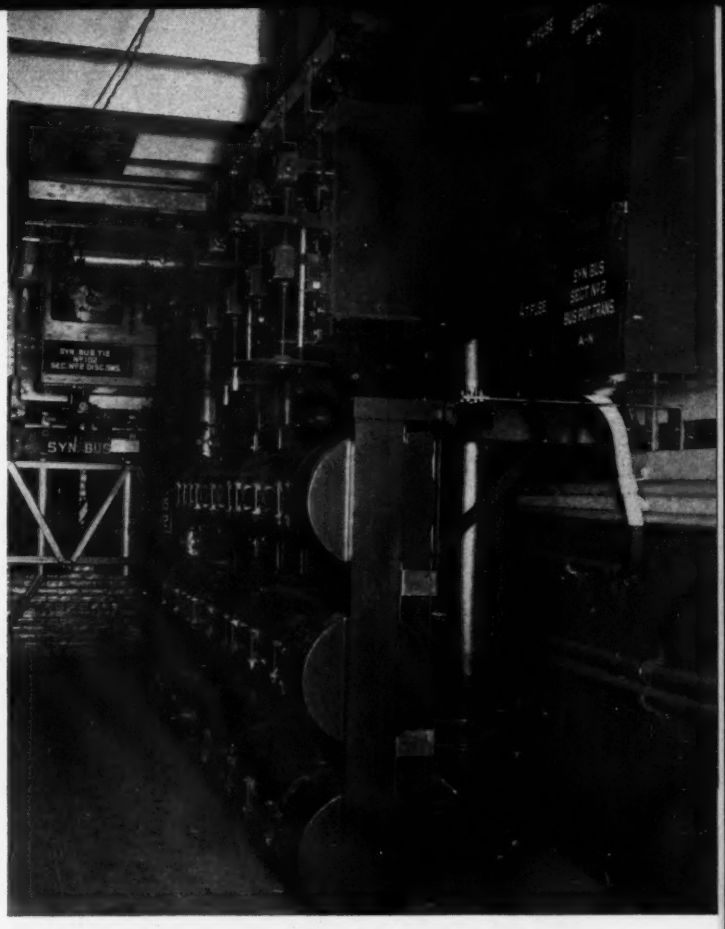
distribution circuits, and such units today are mounted on poles just as distribution transformers are. The great advantage of capacitors over other kinds of voltage regulating equipment lies in the fact that their regulating effect increases in proportion to the increase in line distance from the source. Thus, in one case where automatic capacitors were installed this year it was possible to switch an additional 10 mi. of line with a 600 kv-a. load onto a 17 mi. loaded feeder and yet maintain satisfactory voltage at all points.

Similarly series capacitors are finding greater use on transmission systems but here progress has been less rapid because of the greater difficulties involved. The series capacitor has advantages that cannot be matched by any other type of regulating equipment. Its response to change in load is instantaneous because it reduces the inductive reactance of the circuit to which it is applied. The series capacitor therefore has the widest application to circuits on which the load varies rapidly. As this type of load cannot be handled by induction regulators or other types of regulators the series capacitor occupies a unique position. The operating efficiency of the series capacitor, furthermore, is very high since the losses are proportional to the load and are only 1/3 of 1 per cent of the rating of the capacitor at full load.

There has been little change in high voltage transformers during the year but in view of the fact that these devices are built with efficiencies of 99.46 per cent, two one hundredths of a per cent better than Ivory Soap is said to be pure, this is not surprising. The modern transformer is the most efficient machine man has ever built and further improvement must necessarily be in the direction of greater compactness and perhaps lowered costs. The 275-kv. units for the Boulder Dam lines installed this year are the largest, electrically and physically, ever built. Each unit can carry 48,750 kv-a. continually without air blast and 65,000 kv-a. with it.

In the matter of control, again it is necessary to refer to the Boulder Dam lines to mark development. The carrier current supervisory control system is by far the most comprehensive ever applied. Two 287-kv. lines extend from the power plant just below the dam to a substation just outside of Los Angeles, 266 miles away. At intervals of 90 miles on the desert are switching stations. The operator at the Boulder Dam power house can operate by supervisory control (carrier for everything beyond the local switchyard) all the disconnecting switches and circuit breakers at all four substations. The Los Angeles operator, furthermore, is notified of every operation, automatic or intended.

The developments outlined above show the general trend of progress in the field of power generation and transmission. In a brief article such as this no mention can be made of the hundreds of improvements made in the design, manufacture and operation of particular



The entirely metal covered switching equipment and bus structure installed at Waterside station was an outstanding development in the year's electrical progress

apparatus but in presenting a broad picture this is not essential. The whole field rests on a much sounder and more fundamental foundation than it did ten years ago. There are no really insurmountable problems confronting the electrical engineer today, that is insofar as immediate needs are concerned. The circuit breaker problem which was a difficult one ten years ago today is well in hand and the basic principles involved are much better understood. Carrier current control and relaying is an established fact, the lightning protection question has resolved itself largely into a matter of cost; practically lightning proof transmission lines can be built if money enough is spent on them. This does not mean that all technical problems have been solved and that the electrical engineer's work resolves itself into a question of economics. As a matter of fact the technical problems awaiting solution are greater than ever, but until they are solved we have available today a technique that is sufficient to meet most of our immediate requirements. As longer transmission distances are required, and they undoubtedly will be required, new principles may have to be discovered and developed. The future of long distance transmission may yet lie in direct current lines, the circuit breaker of tomorrow may yet be entirely different from today's most improved forms, even electric generation may change. Some experimental work has been done with electrostatic generators and who knows but that the future electric power system may consist of high voltage electrostatic generators direct connected to direct current transmission lines of a million volts or more rating with electrostatic motors at the receiving end?

Government Projects Boost Hydroelectric

HYDROELECTRIC DEVELOPMENT in this country during the past year as has been the case in other recent years has been confined almost entirely to federal or federally-aided projects. Several small privately owned projects have been constructed, but compared to the total new construction represented in the government projects, these are almost negligible.

This state of conditions reflects no discredit on the privately owned utilities nor does it mean that the government is gradually taking over the power business of the nation; it means only, that hydroelectric development in the United States has reached a point where subsequent developments of large hydraulic resources involve considerations other than power production and that they can no longer be carried out from an economic standpoint on the basis of the sale of power alone. Private interests engaged in the production and sale of power alone are not in a position to develop such resources since the return on the investment on a kilowatt per dollar basis is inadequate. When, however, such developments involve flood control, navigation, and other factors as major objects, it, logically, becomes the function of the government to develop them. In the years of growth of the power industry, the utilities took advantage of every opportunity to develop water power resources, a fact attested by the high percentage of hydroelectric generating capacity installed today compared to the total installed capacity. At the present time between 35 and 40 per cent of all the power produced by public utility plants is produced by hydroelectric power plants. According to the latest figures reported by the Edison Electric Institute at the time of this writing, during the 12 months ending Aug. 31, 1937, the total number of kilowatthours generated by all the electric light and power plants, was 114,033,160,000. Of this total 73,792,220,000 kw-hr. were produced by thermal plants while 40,240,940,000 kw-hr. were produced by water power, or 35.3 per cent. This compares with a figure of 35.9 per cent for the corresponding period a year ago.

The total installed hydroelectric generating capacity in the United States on August 31, 1937 was reported as 9,521,547 kw. This represents 27.8 per cent of the total of 34,236,725 kw. installed in all types of plants—steam, water power and internal combustion. The exact figures for the various types of plants are as follows:

Steam	24,100,415 kw.
Water power	9,521,547 kw.
Internal Combustion	614,763 kw.
Total	34,236,725 kw.

The federal projects now under way call for a total development of about 5,300,000 kw. which, without taking into consideration new capacity which may be added in the meantime by private utilities, will bring the total installed generator capacity to around 40 million kw.

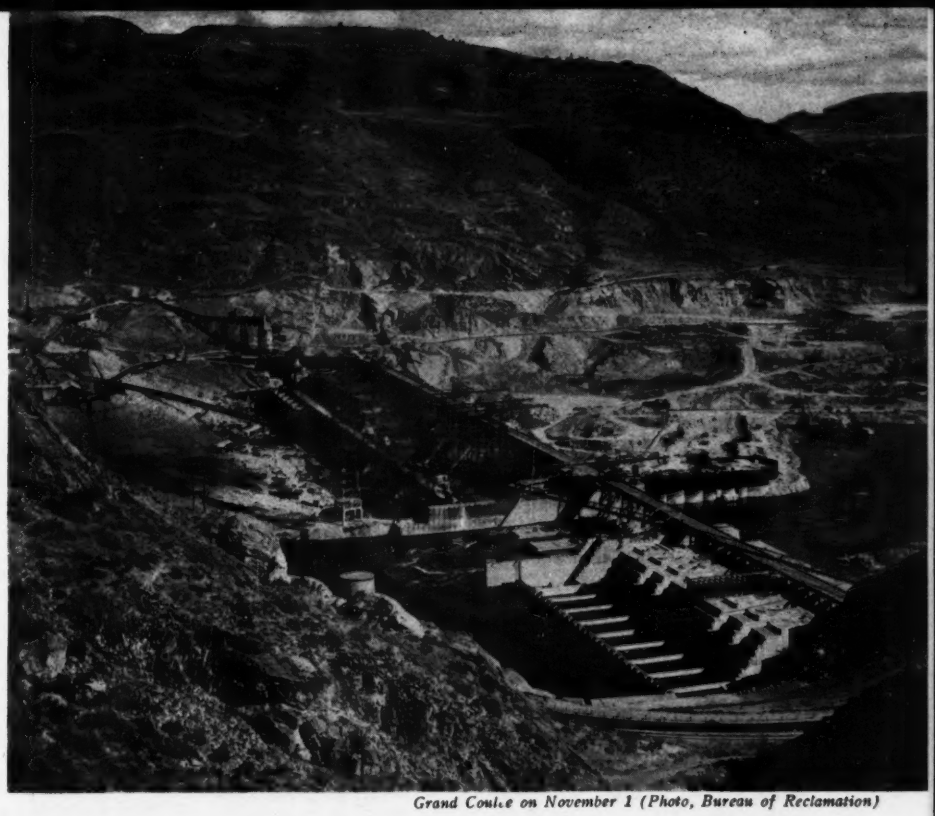
It is obvious, from these figures that hydroelectric power production in the United States is a vital and important part of power production as a whole.

Of the privately owned projects, one of the largest constructed this year is the hydroelectric plant of the Idaho Power Co., at Upper Salmon Falls on the Snake River in Idaho. This project involves a diversion dam which was started in 1931 and a power house with a generating capacity of 18,000 kw. The latter has been under construction during the year and is now ready to go into operation. Two 9,000-kw. generating units are installed together with a bank of 132,000-v. transformers and a 35 mile transmission line to link the new plant with the Idaho Power Co.'s interconnected system at the Shoshone Falls plant.

The London and Marmet hydroelectric plants on the Kanawha River near Charleston, W. Va., can hardly be classified as belonging to this year's hydro developments since they were placed in operation just about a year ago but the first complete description of their engineering features appeared during the year and this may serve as an excuse for mentioning them here. These two low head plants are easily the most important privately owned hydroelectric projects completed in recent years. They were referred to, at the Third World Power Conference, as an outstanding example of cooperative construction by state and private capital since they were designed as component parts of dams previously built by the government for navigation. An interesting feature of these plants was in the selection of the turbines. The equipment at the Loudon Plant consists of three vertical shaft propeller type units, two of which are fixed blade units while the third has an adjustable-blade runner. At Marmet there are also three turbines but here an automatically adjustable propeller of a new type was substituted for one of the fixed blade propellers. The complete description of these two interesting plants appeared in the February number of Power Plant Engineering of this year.

Construction on the various government projects this year has proceeded at a rapid rate and some of these projects have reached initial stages of completion. On September 10, President Roosevelt pressed a telegraph key in his Hyde Park home which started the second of the great generating units at Wheeler Dam of the T. V. A. and on September 28 at Bonneville Dam, he touched the button which started the first generator of that project. At Boulder Dam, during the year, two more 82,500-kv-a. generating units were placed in operation in the Nevada wing of the power house and a 40,000-kv-a. unit on the Arizona side. Thus, there are now four 82,500-kv-a. units and one 40,000-kv-a. unit

Capacity



Grand Coulee on November 1 (Photo, Bureau of Reclamation)

in operation at Boulder Dam. Installation of two more 82,500-kv-a. units is under way. These units will produce power for the Metropolitan Water District of Southern California. Plans have also been prepared for two other 82,500-kv-a. units to be installed in the Arizona wing for the generation of power for the Southern California Edison Co. These units are expected to be ready for operation by the summer of 1939.

The turbine placed in operation at Bonneville is one of ten units which will comprise the ultimate installation there, and is the largest Kaplan turbine ever built. It is rated at 60,000 hp. but can develop 66,000 hp. under favorable conditions of head. The initial installation at Bonneville will consist of two such units. Each unit has a rated water capacity of 12,200 sec. ft. at 50 ft. head. The draft tube diameters are 23 ft. and each unit has five cast-steel runner blades projecting radially from the 10 ft. diameter runner hub. An advance over previous practice in turbine construction in the manufacture of these units was the arc welding of the speed rings, bottom plates and throat rings from pressed plates.

Work at Grand Coulee also has made remarkable strides during the year. In the three years that this project has been under way the great dam has already reached a stage where its final form is becoming evident even to the casual observer. Excavation was started in Aug., 1934. Today, some 4,000,000 cu. yards of concrete have been placed, an amount equal to that used in the entire structure of Boulder Dam. Almost ¾ of a mile long, this key structure of the long range plan for the development of the Columbia river will be 550 ft. high when completed and will contain 11,000,000 cu. yds. of concrete. It will form a lake 151 miles long, extending to the Canadian border. Over 6,000 men are at work on this project and as much as 13,000 cu. yd. of concrete has been placed in a single day.

These projects—Grand Coulee and Bonneville on the Columbia, Boulder Dam on the Colorado, and the development of the Tennessee River as a whole are the great projects of the government at the present time. There are a number of smaller projects involving power such as the All American Canal, and Caspar Alcova which will produce 18,500 and 24,000 kv-a respectively, but compared to the big projects, these are of negligible proportions. From an engineering standpoint, all of these projects are of the utmost interest. They are among the greatest works ever undertaken by man, and the smoothness with which their development has proceeded as well as the marvelous precision with which these structures attain completion is eloquent tribute to the ability and skill of American engineering genius.

The effect of these great developments upon the nation, upon privately owned power companies in their vicinity, upon the well being of the people in the regions served by them and upon the taxpayers of the nation, has been the subject of much discussion, much argument.

With proper administrative objects and policies, separated from politics, these works can contribute to the welfare of the country. Control of a great river and development of all its possibilties for power, navigation, flood control and soil conservation may probably be a task beyond the scope of private organizations. Government is then best qualified for such undertakings, when they are adjudged sound economically by competent experts. The undertaking of such developments may well, however, be based on evident well-proved need and demand for the benefits expected, and the value of each benefit expected should be weighed carefully against its cost, under a proper allocation of total cost of the development among the various objectives to be attained.

In the case of T.V.A., the system as a whole may yield some three million kilowatts of electrical energy, and government is undertaking to develop this power.

Among the recent technical developments in hydroelectric engineering is an automatic aerofoil flow recorder. This device which consists of a simple aerofoil section arranged to rotate through a small angle in a pipe or duct, makes use of the aeronautical principle that an aerofoil in a stream of air sustains uplift forces which are direct functions of the shape of the aerofoil and angle of incidence. Such an aerofoil immersed in flowing water and mounted so as to be capable of rotation takes up a definite position for any particular velocity of flow. In the recorder, the torsional movements exerted in the flowing water are balanced by a simple coil spring, while an extension of the pivoting shaft operates the flow indicator and recording apparatus and any control device.

NEW CHARLESTON PAPER MILL

The new Charleston, S. C., mill of the West Virginia Pulp & Paper Co. is one of a large number of new paper mills recently built or now under construction in the south by the country's leading paper manufacturers. This shift to the south is a significant move to the paper industry. It is equally important from the power standpoint, for these mills are all new from the ground up and the power problem has been handled in as many different ways as there are mills.

This plant was singled out for detailed description not because it is typical but because it represents the solution of the power problem by a company that has been a pioneer in high pressure industrial practice. With years of experience in high pressure operation behind them, the plant cannot in any sense of the word be considered as experimental, rather, the result of a full appreciation of the advantages of high pressures gained from first hand information.

FROM THE THROATS of scores of industrial power plant engineers and executives, wearied with fighting with old equipment, has come the wail "What wouldn't I give for a brand-new, up-to-the-minute high-pressure plant, with no old equipment to hook onto and maintain." Few engineers have this wish granted but the new kraft pulp and board mill of the West Virginia Pulp & Paper Co., just placed in operation at Charleston, S. C., is one of the exceptions. Here is a plant entirely new from the ground up.

All steam is generated at high pressure; two by-product fuels are used; a flexible installation totaling 15,000 kv-a. of generator capacity is tied in with the utility lines. All in all, it is the latest thing in industrial plants.

Of the 423,000 lb. per hr. normal steam capacity 225,000 lb. per hr. or 53.2 per cent of the total is supplied by one of two pulverized coal fired boilers, the second unit serving as standby. A by-product, black liquor, unit makes another 150,000 lb. per hr. or 35.4 per cent of the total, while bark, the second by-product, is burned in a waste heat boiler which makes 48,000 lb. per hr., or 11.4 per cent of the total. All steam is generated at 600 lb. per sq. in. gage, 700 to 715 deg. F. total temperature, with not a low pressure boiler in the plant.

Process steam, at 35 lb. per sq. in., is obtained by extraction from a condensing turbine and from a 35 lb. back pressure turbine, each rated at 7500 kv-a. The 150 lb. per sq. in. process steam is obtained by extraction from the back-pressure unit. This is something fairly new in the paper mill field and the equipment arrangement, the controls, and the provision for instrumentation are unusually interesting.

Here is an engineer's dream—and an accountant's too—of record keeping and instrumentation, including metering and indication of every necessary quantity, not only in the power plant, but also in the mill and distribution lines. To coordinate the four groups of power equipment—coal-burning power boilers, bark burner, recovery unit waste-heat boilers, turbo-generators—a complete system of instruments, automatic combustion controls and turbine and desuperheater controls has been installed.

Paper Mill

The paper mill itself is a paper maker's dream come true. For here is a completely new paper mill, new in every detail from the ground up, even to the occasional use of glass brick instead of windows. It has a capacity of 250 t. of kraft pulp and 250 t. of 0.016 liner board per day made on an enormous 242-in. paper machine, with space enough left in the present machine room to house another similar giant. Because every detail of layout and design of the equipment started from zero, it was possible to work them out so as to take advantage of the tremendous development in materials, methods and equipment made in the past few years. Instead of following the straight line arrangement which has more or less characterized paper mill practice in recent years, the buildings are grouped in an arrangement shown by the small scale drawing, Fig. 2.

One of the first features that impresses the power engineer is the construction of the turbine room building itself. This building, like the machine room, is built with steel frame and has walls of 5 by 12 by 8 in. salt glazed tile. Instead of windows, large panels of glass brick are set into the tile walls, thus giving the building functional, diffused daylight lighting according to the most modern practice. To provide the necessary ventilation, in such a design, ventilators with hoods and ducts are installed on the roof where necessary.

Following the modern practice in plant layout, steam generating and power generating units are arranged in a single room with no curtain wall between. Furthermore, the functional design of the building is carried out by designing it to cover the equipment, with plenty of space for handling equipment, but with no attempt at a decorative architectural design. This very simplicity, however, gives it character. The largest and highest part of the building houses the two large power boilers, the coal hoppers, pulverizer fans and flue gas scrubbers. At the side of these is a section housing the feedwater heater, fire pumps and boiler feed pumps, while in another direction, a section houses the bark-burning boiler. The turbines occupy another space off to the left of the boilers. Boiler control panels and the main steam and feedwater panel are against the wall in front of the boilers. Turbine control, desuperheaters and distribution panels stand close to the turbines, the entire arrangement being shown by the plan and cross section Fig. 3.

OPERATES at 600 lb., 700 Deg. F.

As might be expected in such a modern mill, every possible heat unit, that can be recovered as a by-product of the processes, is used to make steam. But, obviously, this by-product heat, available in the form of bark and black liquor whenever the mill is in operation, will not make enough steam, therefore base fuels—in this case coal and oil—must be burned. Supplementing the coal burned under the power boilers, fuel oil can be burned, to carry low loads, for starting up, or, if necessary, continuously. Oil is also used as a supplementary fuel in the bark burning boiler and recovery units.

Main Steam Generating Units

Two Riley main steam generating units with a maximum continuous capacity of 225,000 lb. per hr. each, referred to as the power boilers, make steam at 600 lb. ga., 715 deg. F. total temperature. They are of the three-drum bent-tube type as shown in Fig. 3, with completely water-cooled furnaces, equipped with a flat refractory floor. Four combination coal and oil burners serve each boiler; they are set in two horizontal pairs, each pair served by one pulverizer.

Coal is delivered to the plant by rail and handled by a Robins crusher and system of conveyors. Cars are unloaded at a track hopper, from which the coal is delivered by an apron feeder to a belt conveyor which feeds a cylindrical storage bin. From there another belt conveyor takes it to the coal hoppers located in front of the boilers and immediately over the firing aisle. Coal carried by the belt is weighed by a Merrick automatic scale before being unloaded into the bunkers by a self-propelled, self-reversing tripper.

From the overhead bunkers above the firing floor, coal feeds to the four pulverizing mills through their respective feeders. The feeders are on the firing floor, the mills in the basement below. Each mill supplies coal to two combination coal and oil burners, the two pairs of burners being toed in to produce turbulence in the furnace. Air for mill drying is withdrawn from the preheated air duct. The burners can be used with fuel oil for starting up, for emergency supplementary firing or continuously. Ash removal from the flat refractory furnace is by hand and truck to tidal flats requiring filling.

Air for combustion is supplied to each furnace by a Sturtevant motor driven forced draft fan with a capacity of 76,200 c.f.m. at 9.2 in. of H_2O. This fan draws air from the boiler room and forces it through a 34,000 sq. ft. tubular air heater designed to give an air temperature of about 550 deg. F. at maximum load. In a modern plant, especially in a paper mill, fly ash cannot be tolerated, so that the flue gas from each unit passes through a Riley scrubber located between the preheater and the induced draft fan. The induced draft fan for each unit is a Sturtevant motor-driven unit with a capacity of 123,000 c.f.m. of 330 deg. F. gas at 9.4 in. of water. This fan discharges through a short steel stack.

Whenever the paper mill is operating, it is producing two by-products, bark and black liquor, that can serve as fuels. The bark is delivered by conveyor to a bin in front of the bark-burning boiler, whence it is fed into a three-section extension bark-burning furnace by a special bark feeder.

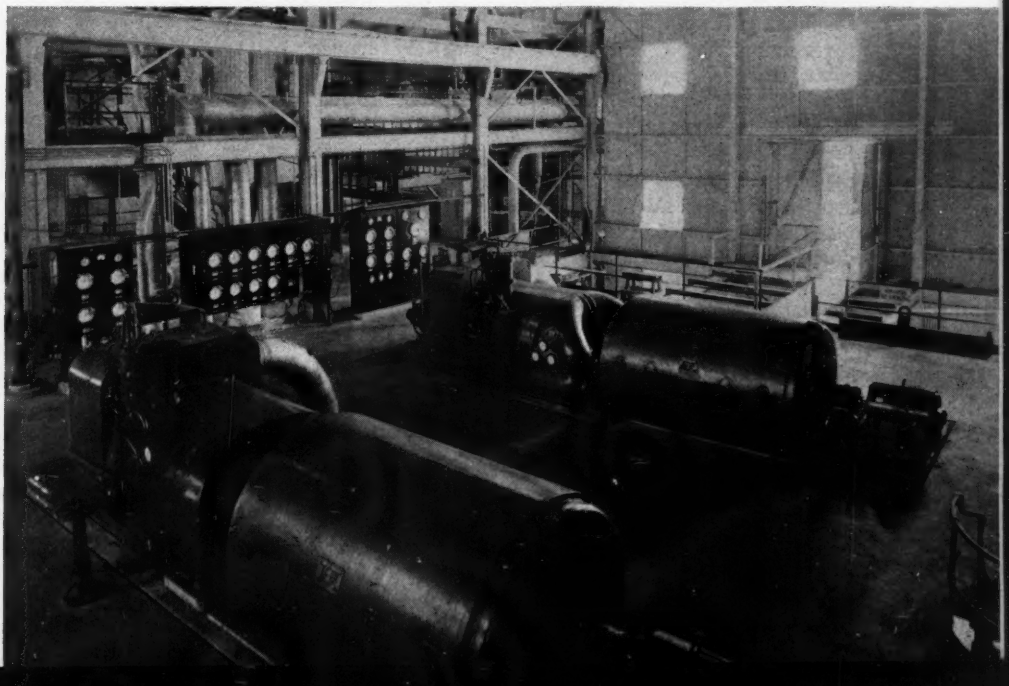


Fig. 1. Looking over the turbines toward the boilers. Each of the two units is rated at 7500 kw., one operates condensing, the other noncondensing, both are arranged for extraction. The boilers, fired by pulverized coal have a capacity of 225,000 lb. per hr. of 600 lb., 700 deg. F. steam. Notice the convenient arrangement of the turbine control, instrument — and desuperheater panels. The combustion control panels are in front of the boilers, considerably to the right of this which is used through the courtesy of The Paper Industry

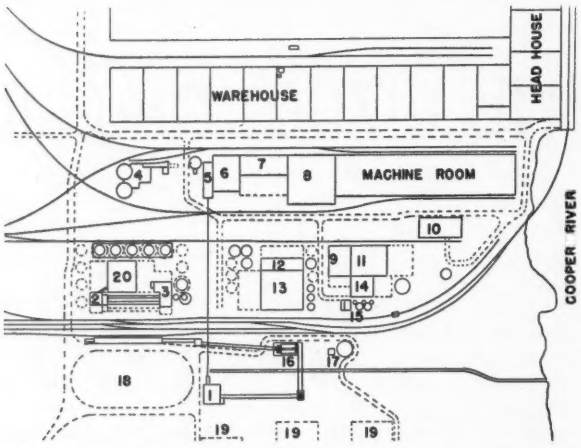


Fig. 2. Plot of the grounds. Instead of following the straight line arrangement popular of recent years, the buildings are grouped. The legend is as follows: 1, Chip house; 2, filter bldg.; 3, caustic room; 4, fatty acid room; 5, digester bldg.; 6, pan room; 7, screen room; 8, Jordan room; 9, power house; 10, shop; 11, power boiler house; 12, evaporator bldg.; 13, recovery bldg.; 14, bark boiler house; 15, water treating plant; 16, barking drums; 17, transformer station; 18, unbarked wood storage; 19, barked wood storage; 20, liquor settling room

The bark-burning boiler, located in the power plant, as shown by Fig. 3, is a B. & W. integral furnace unit with 7293 sq. ft. of heating surface and capable of making 48,000 lb. an hr. of 600 lb., 700 deg. F. steam. This boiler is equipped with a B. & W. 3305 sq. ft. tubular air heater, with Sturtevant motor-driven forced and induced draft fans. The forced draft fan has a capacity of 16,200 c.f.m. at 3.6 in. of water and the induced draft fan, 42,800 c.f.m. at 505 deg. F. at 4.0 in. of water. For maintaining steam supply in case the supply of bark should run low, or for making a small quantity of steam in case the turbine and power boilers are shut down, the bark-burning furnace is equipped with three mechanical-atomizing oil burners, of the B. & W. type, located in the furnace just above the Hofft bark-feeding stoker.

In the large recovery building, adjacent to the power plant, black liquor is burned for the recovery of the ash for chemical processes. This recovery process liberates heat which is recovered in waste heat boilers, producing 600 lb., 700 deg. F. steam. Three of these units are Combustion Engineering Co. Murray-Waern units with three-drum waste heat boilers, a smelter furnace, a rotary furnace, superheaters, integral economizers and disk evaporators. Each has a capacity of 18,900 lb. of black liquor per hr. with 55 per cent solids. The fourth unit is a Babcock & Wilcox Tomlinson with a capacity of 27,000 lb. of black liquor per hr. This consists of a three-drum waste heat boiler, water-cooled black liquor furnace, economizer, air preheater, flues, ducts, spray tower, mixing tank, Bailey metering and regulating equipment and Diamond soot blowers. Manual regulation is used on the three Combustion Engineering Co. units.

Turbo-Generators and Auxiliaries

For flexibility, both a non-condensing and a condensing turbine have been installed. These are both Westinghouse units and each turbine drives a 7500 kv-a. 0.8 power factor, 2300 v., 3 ph., 60 cycle generator at 3600 r.p.m. The non-condensing machine, No. 1, is arranged for extraction at 150 lb. gage and exhaust at 35 lb. gage. Steam at these two pressures passes to two headers leading from the basement of the power house and arranged with a pressure reducing valve between them, so that the 35 lb. system can be supplied from the 150 lb. header as required. The condensing turbo-generator unit, No. 2, is arranged for extraction at 35 lb., to feed to the 35 lb. mill system, and the turbine exhausts to a 8250 sq. ft. Alberger condenser, for which condensing water is taken from the mill supply system. In case the turbines are not operating, steam from the high pressure boilers can be by-passed through a General Regulator Co. reducing valve and desuperheater station connecting the 600 lb. and the 150 lb. lines, or the same by-pass can be used to feed additional high-pressure steam to the process lines in case the turbines are operating at part load.

These low-load conditions, however, will not constitute normal operation, for the generators are connected to the local utility's transmission line, which absorbs much of the difference between what the paper mill is demanding at a given time and the capacity of the generators. Thus the turbo-generators run at full load whenever the paper mill is operating, producing power at the lowest possible cost for both process and transmission lines. If, for any reason, the mills were shut down and no demand existed for process steam, the No. 2 condensing unit could alone produce all the power needed, while in the most extreme emergency, the No. 1 non-condensing unit would afford the utility system a valuable standby unit, both organizations benefiting by the scheme. This also provides each with reserve generating capacity and feeds low-cost, dependable power into the utility system. Under normal conditions, however, the total steam and electrical loads on the plant are relatively steady, as is usual in paper mill operation.

Control and Instruments

Even though these total loads are steady, however, there still remains the problem of coordinating four principal groups of equipment—two pulverized-coal-burning power boilers, a bark-burning unit, four recovery units and the two turbo-generators. As much steam as possible is made with the by-product fuels available, the remaining amount being made by the power boilers. Various steam conditions in the processes may produce requirements of 150 lb. and 35 lb. steam, different from flows corresponding to turbine loads. Recognition of these and other operating problems has led to the fullest use of automatic controls, and of instruments to guide the operators, which leads to smooth operating procedure. At the same time, the records kept by a full complement of recording instruments are invaluable in analyzing operating methods and costs of service to the mill. This cost of power and steam, in the last analysis, is the most important thing about the power plant and since it ranges all the way from 15 to 24 per cent of the cost of paper, every possible means for computing it and reducing it to a minimum is justified.

The recognition by the plant designers of the importance of the foregoing problems in operating procedure and maintenance of low cost of power plant service has led to an installation of Smoot control and Republic instrument equipment that forms a splendid il-

lustration of how advantage can be taken of recent progress in this field. The following summary shows how completely all operating factors have been measured and controlled. In the automatic combustion controls on power and bark-burning boilers a total of 8 Smoot regulators and 3 General regulators are installed. This does not include the 4 manually-controlled regulators on the recovery units. In the boiler plants and turbine room, Republic instruments provide a total of 73 indications, 58 recordings and 26 integrations of pressures, drafts, temperatures and flows of steam, water, black liquor, flue gas and fuel oil.

To operate the power boilers automatically under the foregoing conditions, the Smoot combustion control system governs the fuel supply, the flow of air, and the furnace draft, to maintain steam pressure and combustion conditions for all loads constant. This is done under the supervision of a master controller, responding to changes in steam pressure, at the main header. This master controller transmits master loading pressures simultaneously to a group of regulators which control the various elements.

On the power boilers, the first Smoot regulator varies the speed of each pulverizer feed by operating the motor rheostat. Simultaneously, the vanes of the forced draft fan are moved to the proper position by a second regulator. Furnace suction then controls a regulator, which actuates the vanes of the induced draft fan on each boiler. These fans are driven by two-speed motors. Control can be changed instantly from automatic to manual by a simple lever on the master control panel. A primary air controller, furnished by the General Regulator Co., and operating independently of the combustion control system maintains a constant pressure of ½ in. of water in the primary air duct to each pulverizer. Smoot feedwater level controllers, in which a mercury-differential measuring element, actuated by water level changes, causes a regulator to operate a turbine-type valve in the feedwater supply line, make the operation of each boiler completely automatic.

To provide the operators with a complete picture of operating conditions under the manual or automatic control a complete complement of instruments has been installed on the Republic panels. Indications of furnace draft, suction in the boiler behind the superheater, suction at the boiler exit, at the air preheater exit and at the induced draft outlet, also pressure of secondary air at pulverized coal burners, pressure of air entering heaters and differential draft across the gas side of the air heater, together with steam flow from the boiler in thousands of pounds, are provided by a 10-unit multi-point indicating instrument on each panel. Boiler water level is recorded on a separate circular chart.

Steam flow from boiler, CO_2 at air preheater exit, steam temperature, temperature of air entering the air heater, and of gas entering and leaving it, all necessary for checking boiler performance, are recorded by a 6-pen strip-chart recorder mounted just below the multi-point indicator. An integrator totalizes steam flow from each boiler so that a convenient record of total production can be obtained over long periods.

Push button controls adjust high and low speeds of forced draft and induced draft fans and pulverizer feeders. Ammeters show the operating status of pulverizers and fans. Boiler drum pressure is shown by an indicating gage.

Combustion Controls and Instruments for Bark Burning Boiler

The bark-burning boiler is not under full combustion control, since its operation depends to a large extent on the amount and character of bark available as fuel.

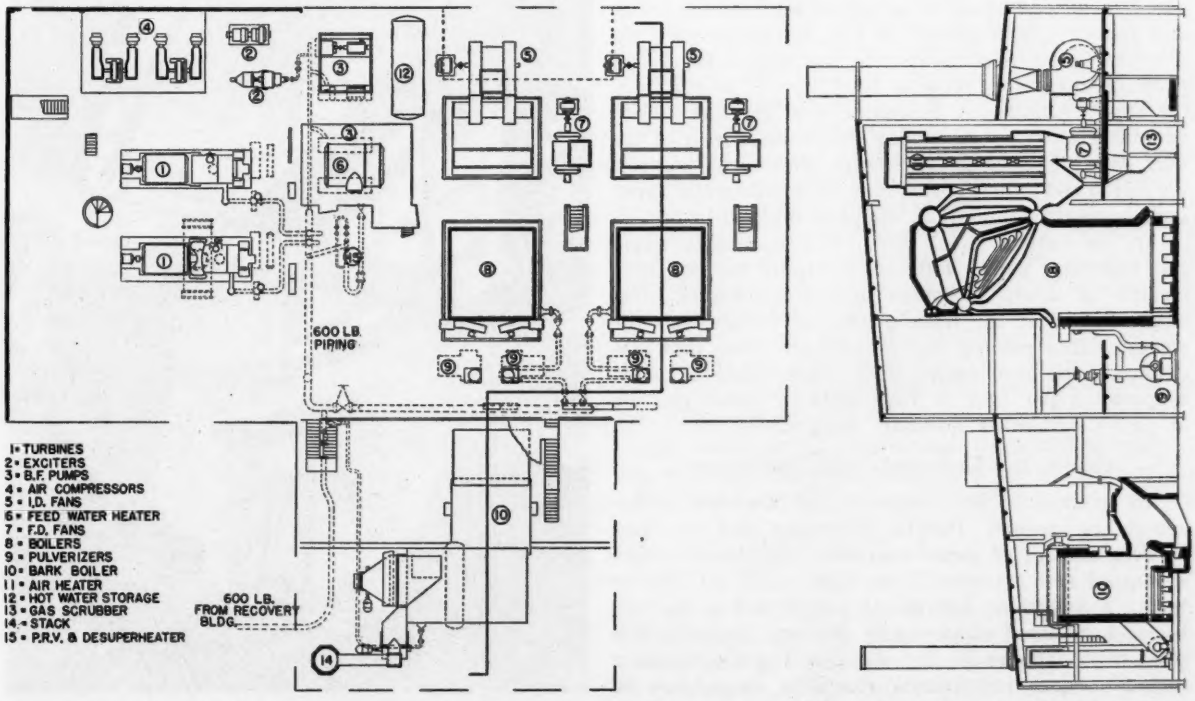


Fig. 3. The two power boilers have a capacity of 225,000 lb. per hr. of 600 lb., 700 deg. F. steam and are fired by pulverized coal. The generators are rated at 7500 kw.

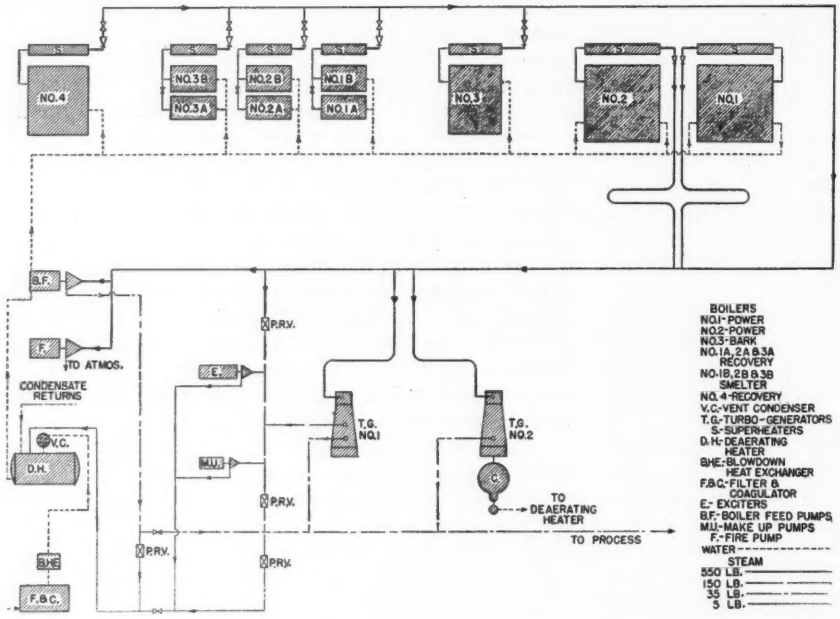


Fig. 4. Steam and water flow diagram. This shows the complete system of power boilers, bark boiler and recovery units. The latter are located in a separate building

However, a Smoot regulator controls the inlet damper of its induced draft fan in accordance with the draft in the furnace, the other combustion equipment being hand-controlled.

In the operation of this boiler the operator observes the following factors on a 9-unit multi-point indicator: the furnace suction; the suctions at boiler exit and air preheater exit; the air pressures under three zones of the bark-burning stoker; pressure at forced draft fan discharge; finally, the quantity of steam made by the boiler. A strip-chart recorder provides a record of steam flow from boiler, total steam temperature, temperatures of air leaving the air preheater, of gas entering and leaving it, and percent of CO_2 in the flue gas. On this panel, too, is a round-type recorder, with accompanying integrator, showing total flow of steam from the recovery units. A feedwater level recorder, steam flow integrator for registering steam production of the unit, gage for boiler drum pressure, push-button controls for forced and induced draft fans and ammeters, showing their current consumption, complete the panel.

In the control panel group is also a main steam and feedwater panel, designed to supply the necessary records of steam pressures and temperatures, total steam output of the three groups of boilers, and the corresponding records for feedwater. These data are essential both in operation, and in computing economy, evaporation per unit of fuel, costs of steam per ton of paper, and other necessary calculations.

Turbine and Desuperheater Instruments

In controlling the operation of the two turbo-generators, several factors determine the relations between amount of power generated and flow of steam exhausted and extracted from these units for process work. Two turbine instrument panels and a desuperheater instrument panel supply the data for doing this effectively. The panel for the No. 1 non-condensing turbine carries instruments recording steam flow to turbine throttle; flow, pressure and temperature of 150 lb. extraction steam and exhaust steam, lubricating oil pressure and temperature. The panel for No. 2 turbine carries the same number and type of recorders, except that they are for 35 lb. extraction pressure and condenser vacuum, since this unit exhausts to a condenser. This panel also carries a barometer. On both panels, indicating watt-meters and electrical control switches are mounted. All steam flows are totalized by integrators.

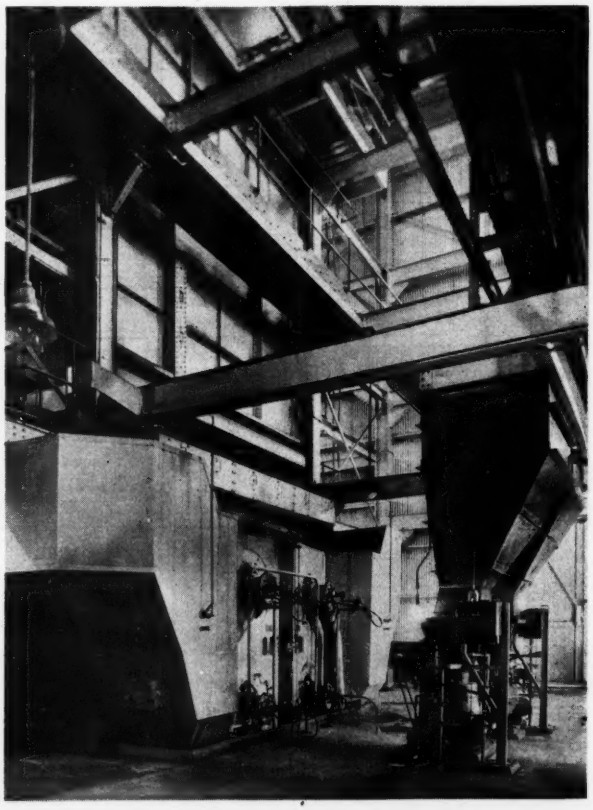


Fig. 5. The firing aisle showing four burners and the two pulverizer feeders for one boiler

On the desuperheater panel, flow of 600-lb. steam to the 600-150-lb. reducing valve, pressure and temperature at desuperheater outlet; flow from the desuperheater to the 150-lb. header and flow at the 35-lb. reducing valve are recorded. Pressure gages for the 150-lb. and 35-lb. steam headers, a desuperheater hand control valve and integrators for all these steam flows complete the panel.

In operation, these turbine records show the amounts of steam extracted for process work in relation to the total steam supplied to the turbines. They provide data for calculating or checking the heat balance, also for determining costs of power and of process steam, especially important in view of the fact that a certain proportion of the electricity generated by process steam is fed to the public utility lines.

Steam and Water Distribution Instruments

The primary object of all the steam and power generating equipment is to operate the paper mill to make paper. Hence a record must be kept, for both cost

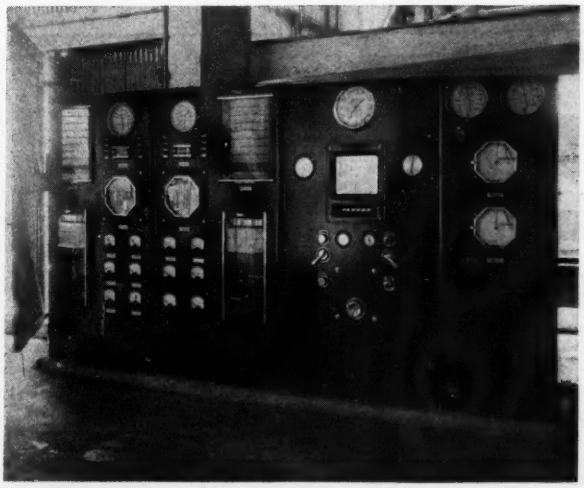


Fig. 6. Power control panels located in front of the boilers as indicated on the plan Fig. 3 (Photo, The Republic Flow Meters Co.)

accounting and heat balance purposes, of all the electric power, steam and water that the power plant supplies to the processes.

In this case these records are provided by a steam and water distribution panel carrying 16 single-pen recorders and integrators. These show the flows of steam to paper machines, digesters, evaporators, boiler feed pump header, feedwater heater. They record: flow of water to power boilers; flow of condensate return; flow of makeup water to feedwater heaters; flow of raw water to water softener.

On three of these integrators—those registering flows to boiler, makeup to feedwater heater and total raw water to softeners—electrical contactors operate in such a way that as each 1000 gal. of water is registered, a proportioning device in the water softening equipment injects a predetermined supply of chemical solution into the water.

Instruments for Recovery Units

Instruments for guiding the operators of three of the recovery units are grouped conveniently on three

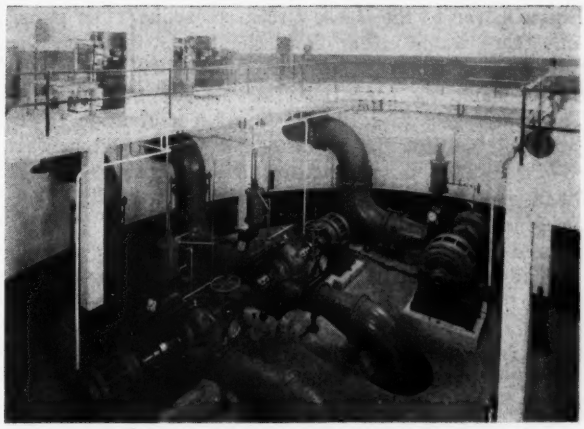


Fig. 7. The pumping station with a combined capacity of 50 m.g.d. is located about 5 m. from the mill (Photo, The Paper Industry)

panels, one near each unit, in the separate recovery unit building adjacent to the power plant on each panel. A 10-unit multi-point indicator shows the operator the draft in the smelter furnace, draft at the outlet of the economizer of the waste heat boiler, the disk evaporator outlet draft, nozzle air pressures and furnace secondary air pressure. In these units the temperature of flue gas at the outlet of the disk evaporator is extremely important in operating the unit, for it is related to the solid content of the liquor. This temperature is recorded by one pen of a three-pen circular chart recording instrument, the other pens recording steam temperature and boiler outlet gas temperature. On a 10-point multi-point indicator, flows of primary air and disk evaporator outlet draft are shown the operator.

To obtain data on the amount of steam made from a given amount of black liquor, two important flow measurements—flow of steam from the unit and flow of heavy black liquor to the fuel jets—are recorded and integrated. The black liquor flow meter from which these recordings are taken is of the pressure-separation type, designed to prevent the black liquor from solidifying in the pressure connections and to create a pressure differential proportional to that produced at the meter orifice in the pipe in which the flow is measured.

Indicating pressure gages show the operator the waste heat boiler drum pressure, smelter boiler drum pressures and pressure at the main steam header into which the recovery units feed steam at 600 lb. per sq. in.; this header carries the steam produced by the recovery unit to the main 600-lb. manifold in the power boiler room. Feedwater pressure for the recovery boilers is also shown by an indicating gage.

In measuring the flows and quantities mentioned above, most of the instruments used are of the Republic electrically-operated, remote-reading type.

Water Supply

In a mill of this type the water problem is an important one and in this case involves in an unusual way a close cooperation between the company and the city of Charleston. Water contracted for by the company is sufficient to guarantee the interest on bonds sold in order to finance the completion of the tunnel from the

Edisto River to the Goose Creek reservoir. The paper mill takes water either from the tunnel or from the reservoir, a 40,000 g.p.m. pumping station being built by the company near the reservoir for this purpose. This water goes to a 10,000,000 gal. combination reservoir and settling basin near the plant. From this reservoir, a 48 in. concrete pipe line branches into a 36 in. pipe line forming a loop around the mill. Connections are taken off the loop for distributing water as needed in the pulp and paper mill operation.

The maximum capacity of this pipe line system is 50,000,000 gal. per day. Of this about 1,000,000 gal. per day is used for boiler feedwater. Treatment of the boiler feedwater supply consists of coagulation, settling and filtration followed by a secondary phosphate treatment controlled automatically. A continuous blowdown system, with suitable heat recovery equipment, is installed in the power boiler and bark-burning boiler.

Feedwater, a combination of condensate return and treated water, is heated to 215 deg. in an Elliott deaerating feedwater heater, using part of the exhaust steam from the boiler feed pump turbine after it has passed through a pressure-reducing valve. The boiler feed pumps are on the operating floor below the heater and consist of three Ingersoll-Rand centrifugal pumps each with a capacity of 1000 g.p.m. against a total head of 1776 ft. Two of these pumps are driven by Terry steam turbines and one by a General Electric motor. The pumps may be used in various combinations depending upon the heat balance requirements at the time.

The power plant described above, one of the outstanding industrial designs of the year, was one unit, albeit a most important one, in the design of the new mill at Charleston. Design and construction were carried out by the Engineering Dept. of the West Virginia Pulp & Paper Co., with the close cooperation of Morton C. Tuttle Co., general contractors for the building of the entire mill. It is apparent that this new paper mill has been provided with a power plant conforming to the latest and best practice in the industrial field, one that should prove a powerful factor in keeping the cost of paper at the lowest possible point, consistent with reliability and with the high quality of product for which the West Virginia Pulp & Paper Co. is noted.

LIST OF PRINCIPAL EQUIPMENT—WEST VIRGINIA PULP & PAPER CO., CHARLESTON, S. C.

BOILER EQUIPMENT

STEAM GENERATING UNITS—Riley Stoker Corp., 2 units, 3-drum, bent-tube type, 225,000 lb. per hr. each at 600 lb., 715 deg. Boiler heating surface 11,400 sq. ft.; total water-wall surface 6450 sq. ft.; superheater heating surface 2050 sq. ft.; tubular-type air preheater; flue gas scrubber. Furnace: 11,200 cu. ft., water-cooled, flat bottom with refractories.

COAL BURNING EQUIPMENT—Riley Stoker Corp., 4 Atrita pulverizers, (2 per boiler) with feeders, motor-driven by General Electric Co. 2300 v. motors; 8 burners, (4 per boiler) combination pulverized coal and oil.

DRAFT FANS—B. F. Sturtevant Co., 2 forced draft fans for power boilers, each 76,200 c.f.m. against 9.2 in. of H_2O driven by 150-63 hp., 1170-860 r.p.m. General Electric Co. two-speed motors; 2 induced draft for power boilers, each 123,000 c.f.m. of 400 deg. gas against 9.4 in H_2O, driven by 300-93 hp., 860-580 r.p.m. General Electric Co. two-speed motor.

BOILER FEED PUMPS—Ingersoll-Rand Co., 3 centrifugals with a capacity of 1000 g.p.m. against a 1776 ft. head at 3500 r.p.m. Two driven by Terry turbines and one by a 600 hp. G.E. 2300 v. motor drive.

BARK-BURNING BOILER—Babcock & Wilcox Co., 1 integral furnace unit, 48,000 lb. steam per hr., at 600 lb., 700 deg. F. Boiler heating surface 7293 sq. ft.; integral loop-tube superheater, air preheater, 20 and 50 hp. General Electric Co. motor-driven forced and induced draft fans respectively., B. & W. mechanical-atomizing oil burners for oil firing to supplement bark.

BARK-STOKER—M. A. Hofft Co., 3 compartment furnace, extension type.

COAL-HANDLING EQUIPMENT—Robins Conveying Belt Co., track hopper, 100 t. per hr. apron feeder, 24 in. by 205 ft. belt conveyor, reciprocating feeder, 16 in. by 255 ft. belt conveyor, self-reversing self-propelled tripper, Merrick Weightometer, cylindrical coal storage bin, motors, chutes and gates and all structural steel and housing for equipment.

RECOVERY UNITS—Combustion Engineering Co., 3 Murray-Waern units consisting of three bent tube waste heat boilers, (each 32,500 lb. per hr. of steam at 600 lb. pressure 700-deg., when burning 18,900 lb. black liquor 55 per cent solids); smelter furnace; rotary furnace; superheaters; economizers; disk evaporators and Smoot manual regulation. Babcock & Wilcox Co. 1 Tomlinson unit, with three drum waste heat boiler, to make 52,000 lb. steam an hour at 600 lb. 700 deg.; water-cooled black liquor furnace; flues and ducts; spray tower; mixing tank; Bailey metering and remote control equipment.

SOOT BLOWERS—All units; Diamond Power Specialty Co.

BLOW OFF VALVE—Yarnall-Waring Co.

VALVES—Steam, safety, water, etc., Chapman Valve Mfg. Co., Consolidated-Ashcroft-Hancock; Pratt & Cady Co., Inc.

PIPING—Jones & Laughlin Steel Co., Walworth Co.

PIPE INSULATION—Philip Carey Mfg. Co.

POWER PLANT CRANE—Whiting Corp.; 20 t.

FEEDWATER HEATER—Elliott Co.; deaerating type, capacity 600,000 lb. per hr.

FEEDWATER PUMPS—Ingersoll-Rand centrifugal pumps, 2 driven by Terry turbines, G.E. Co. motor.

FEEDWATER TREATMENT—Permutit Co.; Includes chemical feeding equipment and continuous blowdown equipment. Coagulation, setting and filter tanks, constructed by Chicago Bridge & Iron Co.

PIPE FITTINGS (welded)—Tube Turns, Inc.—Grinnell Co.

WATER COLUMNS—Reliance Gauge Column Co.

STEEL STACKS—Ingalls Iron Works Co.

TURBINE EQUIPMENT

TURBO-GENERATORS—Westinghouse Electric & Mfg. Co., Throttle steam, 600 lb., 700 deg. One non-condensing turbine, 7500 kv-a., extraction at 150 lb. ga., exhaust, 35 lb. ga. One condensing turbine 7500 kv-a.; extraction at 35 lb. ga. and exhaust to Alberger 8250 sq. ft. surface condenser, Two condensate pumps, Condensing water taken from the mill water supply system. Each turbine drives a 7500 kv-a., 0.8 p.f., 2300-v., 3-phase, 60-cycle Westinghouse generator at 3600 r.p.m., and a 39 kw. direct-connected exciter.

SPARE EXCITER; General Electric Co., 74 kw. steam driven; throttle steam 150 lb., exhaust 5 or 0 lb. gage.

AIR COMPRESSORS—Chicago Pneumatic Tool Co.

ELECTRICAL SWITCHBOARD PANEL—Wolfe & Mann Co.

MOTOR-GENERATOR SETS—General Electric Co., one 240 kw. d.c. generator with 2400 v. 3 ph., 60 cycle, 1200 r.p.m. 350 hp. synchronous motor.

SWITCHING EQUIPMENT—General Electric Co., I.T.E. Circuit Breaker Co., Cutler Hammer, Inc., Allis-Chalmers Mfg. Co.

ELECTRIC MOTORS—General Electric Co., Westinghouse E. & M. Co., Reliance Electric Co., Louis Allis, Inc.

TRANSFORMERS—General Electric Co.

CONDUIT—Clifton Conduit Co., Triangle Conduit Co., Control equipment and instruments.

WIRE—Anaconda Wire & Cable Co.

ELECTRICAL TESTING INSTRUMENTS—Weston Electrical Inst. Co., J. G. Biddle Co.

ELECTRIC METERS—General Electric Co., Westinghouse E. & M. Co., Esterline-Angus Co., voltmeters, ammeters, watt meters, turbine electrical instruments, recording watt meter.

TACHOMETERS—James G. Biddle Co.

GAGES—Consolidated-Ashcroft-Hancock; U. S. Gage Co., Foxboro Co., Behrer-Nason Co.

THERMOMETERS—Moeller Co., Minneapolis-Honeywell Mfg. Co.

OIL METERS—National Meter Co.

AUTOMATIC COMBUSTION CONTROL—Smoot, Republic Flow Meters Co. For the power boilers, 6-tube master controllers and 8 oil-operated regulators; for the bark-burning boiler, 1 induced draft fan regulator; for primary air regulation to pulverizers, 3 regulators by General Regulator Co. Manual combust on regulation on the recovery units: 3, Smoot, Republic Flow Meters Co., 1 Bailey Meter Co.

FEEDWATER LEVEL CONTROL—Smoot, Republic Flow Meters Co. for 2 power boilers, 2 regulators and two 600 lb. 3-in. turbine-type valves. Swartwout Co. for bark burning boiler and recovery units.

CONTROL PANELS (7)—Republic Flow Meters Co.

BOILER CONTROL PANELS—2 panels for power boilers, each carrying 9-unit multipoint indicator, 6-pen strip chart recorder, integrators, boiler water level recorder and pressure gages; 1 panel for bark-burning boiler carrying similar instruments.

MAIN STEAM & FEEDWATER PANEL—carries pressure gages and pressure and temperature recorders.

DISTRIBUTION PANEL—carries recorders for flow of steam, water to processes.

RECOVERY BOILER CONTROL PANELS—3 panels, each carrying 10-unit multipoint indicator, 3 round-type recorders, push-button controls, speed indicator.

TURBINE CONTROL PANEL—carries 8-round type recorders for various high and low pressure steam records, integrators, control switches, barometers, etc.

REDUCING VALVE & DESUPERHEATER INSTRUMENT PANEL—carries 3 round-tyne recorders and integrators to record low pressure steam flows through 150 lb. and 35 lb. lines.

PRESSURE REDUCING VALVES AND DESUPERHEATER—General Regulator Co. for 700 deg. to 450 deg. temp. reduction, capacity 200,000 lb. per hr., with temperature controller; and pressure reductions from 600 to 150 and 35 lb.

BOILER WATER PH. RECORDERS—Leeds & Northrup Co.

BAROMETERS—C. J. Tagliabue Mfg. Co.

POWER HOUSE HOLLOW TILE WALLS—National Fireproofing Co.

POWER PLANT VENTILATION SYSTEM—J. O. Ross Eng. Corp.

The accurate calculation of the steam rate of a turbine is a tedious process, one indulged in as rule only by turbine designers. In this article, however, Mr. Newman presents a new method by means of which close estimates of turbine performance can be made with little effort. These short cuts dispense with all laborious calculations and will be found extremely valuable to all users and operators of turbines.

MODERN TURBINES*

By
L. E. NEWMAN
Turbine Div. General Electric Co.
Lynn, Massachusetts

FOR EVERY DOLLAR SPENT in buying a condensing turbine-generator set, the chances are that another dollar will be spent *each* year to keep it supplied with steam. So the statement that "the efficiency will be remembered long after the price is forgotten" has special significance when applied to turbines. For day after day, year after year, turbines are called upon to generate power continuously and economically. They should be thought of as an investment in power which will return kilowatts of energy for fuel burned.

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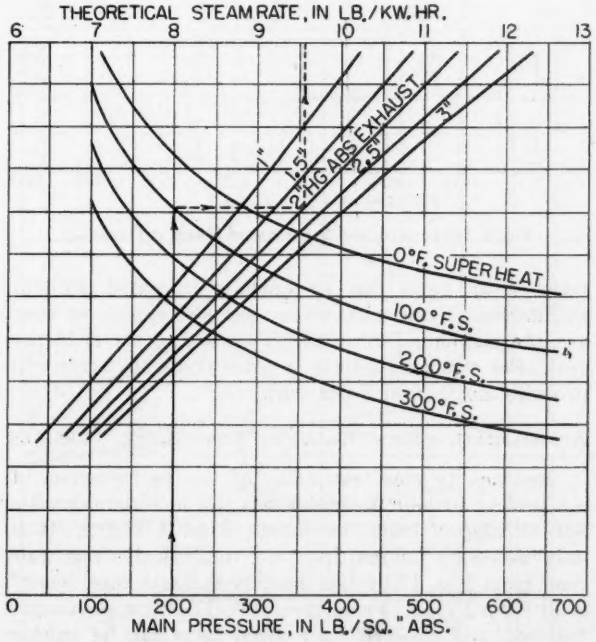


Fig. 1. Approximate Theoretical Steam Rates for Condensing Turbines.

NOTE: Absolute pressure in lb. per sq. in. = lb. per sq. in. gage + 15 lb. (at sea level)

Absolute pressure, in inches Hg. = 30 minus the Vacuum, in inches (at sea level)

The steam required by a turbine to generate this power is often termed the "steam consumption," meaning the total number of pounds of steam required to produce a given power output. But steam "consumption" is a misnomer. Turbines do not "consume" steam, but take heat energy out of the steam, passing the steam supplied to them out of their exhausts undiminished in weight. Like hydraulic turbines where water at high velocity goes through the turbines and then continues on its way unchanged except for the loss of that velocity, so steam goes through turbines unchanged in quantity but reduced in pressure.

"Steam rates" or "steam flows" are more descriptive terms than steam consumption. Usually steam rates are expressed as the number of pounds of steam required to generate one kilowatt hour (or horsepower hour); steam flows as the total number of pounds of steam required each hour for a given power output. But whether steam rate or steam flow is used, either will be expressed as the weight of steam. It is the weight of steam flow that determines the output, other conditions being constant.

Turbine designers in calculating steam rates must think in terms of steam velocities, number of stages, and steam path areas, but for others it is more convenient to think in terms of the theoretical steam rate (the theoretical number of pounds of steam required to generate a given unit of power.) It will be remem-

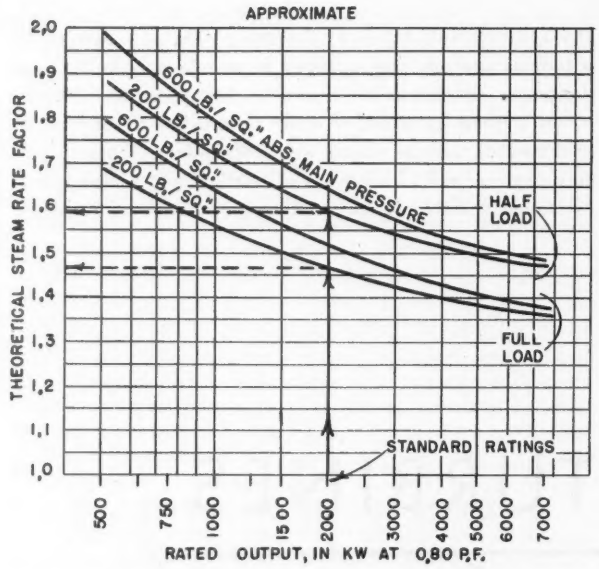


Fig. 2. Steam rates of Condensing Turbine-Generator Sets. Full load steam rate in lb. per kw.-hr. = theor. S. R. × theor. S. R. Factor. Half load steam rate in lb. per kw.-hr. = theor. S. R. × theor. S. R. Factor

bered from the preceding article that the theoretical steam rate is obtained by dividing the heat equivalent of a kw-hr. (3413 BTU) by the available energy in BTU per pound of steam. The theoretical steam rate is the *number of pounds* of steam required by an ideal turbine, having an efficiency of 100 per cent, to generate *each* kilowatt-hour of power. When it is divided by the efficiency of the turbine the result will be the actual steam rate. So, assuming the efficiency remains constant (and for sizable changes in output the turbine efficiency does not change very much) it can be said that, *the output of a turbine operated with constant steam conditions is determined by the weight of steam flowing through it.*

The available energy, expressed as a theoretical steam rate, may be anything from a few pounds to over a hundred pounds of steam. It is subject to wide variation with different steam conditions, but may be accurately and easily determined. On the other hand, the efficiency of most multi-stage turbines is not subject to wide variation, and may be readily approximated. This is a happy combination, for a sound engineering principle applying to the making of estimates of all kinds could be stated, "accurately determine the important factors and estimate the factors which will have little influence on the result." The theoretical steam rate falls in the first group, being a factor varying over a wide range yet which may be readily determined. Efficiency, for estimating purposes, may be placed in the second group, for it varies through a limited range and may be readily approximated.

Before using this reasoning to set up methods for quickly estimating the performance of condensing and noncondensing turbines it may be advantageous to consider the maximum tolerable error. Manufacturers guaranteeing the performance of turbines spend many hours making calculations of great precision to determine within small limits of error the performance of each turbine. If errors of two per cent could be tolerated it is probable that the time for calculating could be cut at least in half. Experienced designers, with no calculations on which to base their estimate, could guess the steam rate for almost any set of conditions within plus or minus 25 per cent. The law of diminishing returns operates to increase rapidly the time required for calculation with each succeeding reduction in permissible error.

But time is usually an important factor when preliminary studies are being made. If time can be saved, some increase in the permissible error can often be made without impairing the value of the study. Then, as progress is made in the preliminary study and reduction in tolerable error is desirable, reference can be made to manufacturer's district turbine specialists from whom close estimates of performance may be obtained. With these things in mind, estimating methods of great simplicity were set up for this article from which approxi-

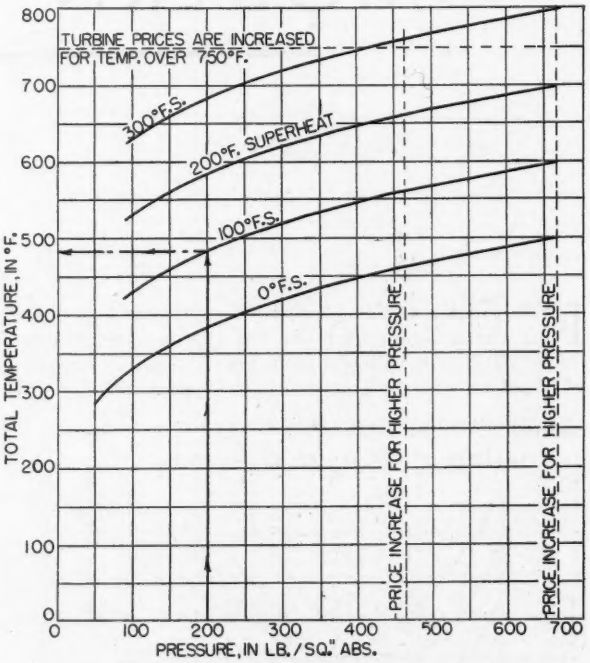


Fig. 3. Temperature and Superheat of Steam vs Pressure.

mate steam rates can be quickly estimated without calculation. Even with these methods, simple as they are, the maximum error will be limited to about 10 per cent. For steam conditions in general use the error will probably not exceed 5 per cent.

Approximate Steam Rates of Condensing Turbines

Reasonably close estimates of the performance of condensing turbine generator sets can be obtained *without calculation* from the charts, Figs. 1 and 2. It is only necessary to multiply the theoretical steam rate read from Fig. 1† by the theoretical steam rate factor* read from Fig. 2. From these two charts approximate full-load and one-half load steam rates can be quickly estimated for almost any modern multi-stage condensing turbine generator set rated from 500 to 7500 kw.; and

†Tables of Theoretical Steam Rates were presented before the A.S.M.E. by E. E. Harris, General Electric Company.

*"Theoretical steam rate factor" is the reciprocal of efficiency.

operating with any initial steam pressure from 100 lb. per sq. in. to 650 lb. per sq. in. absolute. These steam rates can be obtained in a minute's time without even a slide rule and are sufficiently close for preliminary studies.

Suppose, for example, that you wanted to know what improvement in steam rates to expect if you installed a modern 2000-kw. set in place of "old reliable" whose 17-lb. steam rate looked good twenty years ago, but which now you were beginning to question. Then the conditions might be set up as:—

Existing turbine generator set rated 2000 kw., .80 P.F., 2400 v.

Operating with steam conditions of 200 lb. per sq. in. abs., no superheat, and 2 in. Hg. abs. exhaust pressure.

Steam rate at 2000 kw. load = 17 lb. per kw-hr.

Assume, too, that you believe that you can't quite stand the expense of a new boiler, but are willing to add superheaters to the old boilers as a compromise. You don't hesitate to add the superheaters because you know that in addition to improving the steam rate of the new turbine, the superheated steam will minimize replacement of wearing parts in the steam path. So the new conditions might be set up as:—

New 2000-kw. turbine generator set operating with steam conditions of 200 lb. per sq. in. abs., 100 deg. F. superheat, and 2 in. Hg. abs. exhaust pressure.

Steam rate at 2000 kw. load = 14.0 lb. per kw-hr.

Improvement over old machine = 17 per cent.

The steam rate of the new turbine was obtained by entering Fig. 1 with 200 lb. per sq. in. abs., reading up to 100 deg. F. superheat, and then across to the theoretical steam rate at 2 in. Hg. abs. This theoretical steam rate was multiplied by the factor read from Fig. 2. Thus,

Theoretical steam rate = 9.55 lb. per kw-hr.

Full-load steam rate = $9.55 \times 1.46 = 14.0$ lb. per kw-hr.

One-half load steam rate = $9.55 \times 1.59 = 15.2$ lb. per kw-hr.

Compared to the old 17-lb. steam rate the steam rate of the new modern turbine is 17 per cent better, but all of this gain is not reflected as a reduction in cost of fuel. Unless the efficiency of the old boiler is improved when superheaters are installed, slightly more fuel will be burned in generating each pound of steam at 100 deg. F. superheat than was formerly required to generate each pound of steam having no superheat. So while 17 per cent is the reduction in steam rate, the additional fuel required to superheat the steam will cut this gain in terms of fuel consumption to about 12 per cent.

Maybe 12 per cent gain is enough to make the installation of a new turbine worthwhile. If it isn't, perhaps you may want to check what gain in steam rate is probable if you retain the old boiler and turbine for "standby," and replace them with a new 600-lb. boiler and turbine. The new boiler with its improved efficiency will probably generate 600-lb. steam just as cheaply as the old boiler generated each pound of steam at 200 lbs. pressure. So you can just about figure that any gain in steam rate for the new turbine will mean that much reduction in your annual fuel bill. The proposed new conditions could be assumed as:

New 2000-kw., 600 lb. turbine generator set operating with steam conditions of 600 lb. gage, 200 deg. F. superheat, and 2 in. Hg. abs.

Steam rate at 2000 kw. (full-load) = 11.2

Steam rate at 1000 kw. (½ -load) = 12.1

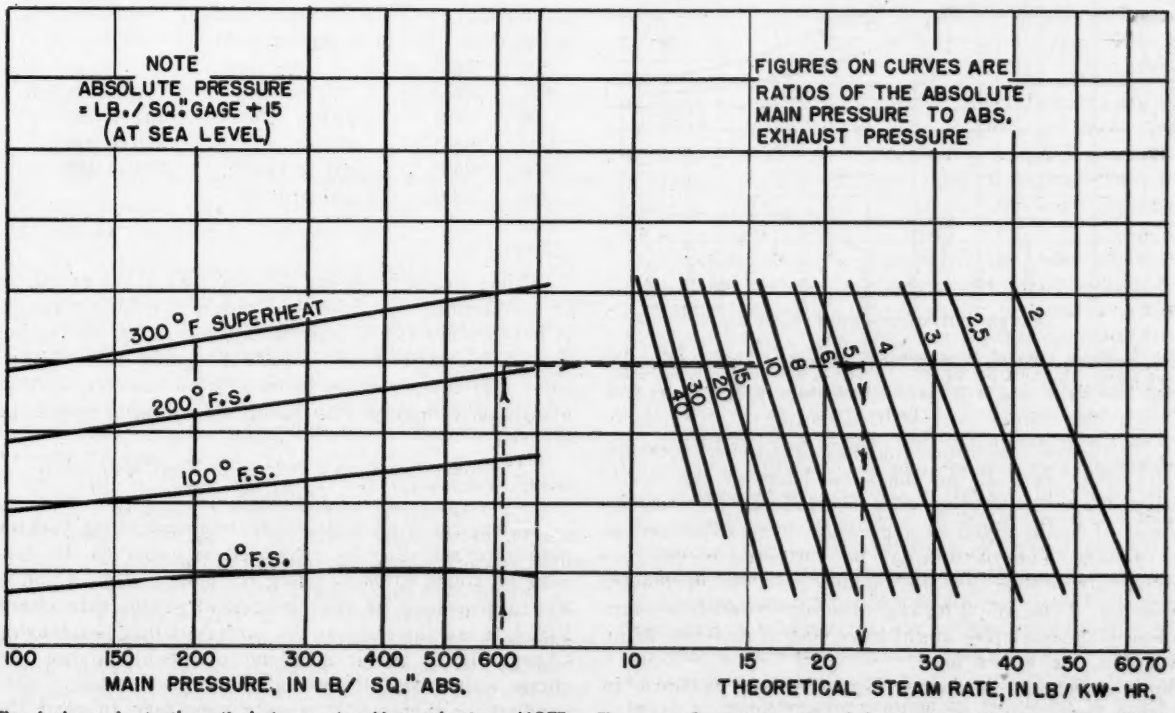


Fig. 4. Approximate theoretical steam rates, Noncondensing. NOTE: Figures on Curves are ratios of the absolute main pressure to absolute exhaust pressure.

Before checking the method of deriving these steam rates, note that the main pressure was given in lb. per sq. in. gage. To convert this to the same basis as the curves the atmospheric pressure of 15 lb. per sq. in. abs. must be added. So the steam conditions are:

615 lb. per sq. in. abs., 200 deg. F. superheat, 2 in. Hg. abs.

From Fig. 1

Theoretical steam rate = 7.38 lb. per kw-hr. and from Fig. 2, and multiplying

Load	TSR	TSR Factor	Est. Steam Rates
2000	7.38	1.52	11.2
1000	7.38	1.64	12.1

If this 11.2-lb. steam rate is compared to the old 17-lb. steam rate the gain is 34 per cent. When 34 per cent is taken off the annual fuel bill, and this saving considered along with improved governing, added reliability, and low maintenance it may seem desirable to make a careful study of the proposition with the assistance of manufacturers specialists and perhaps a consulting engineer.

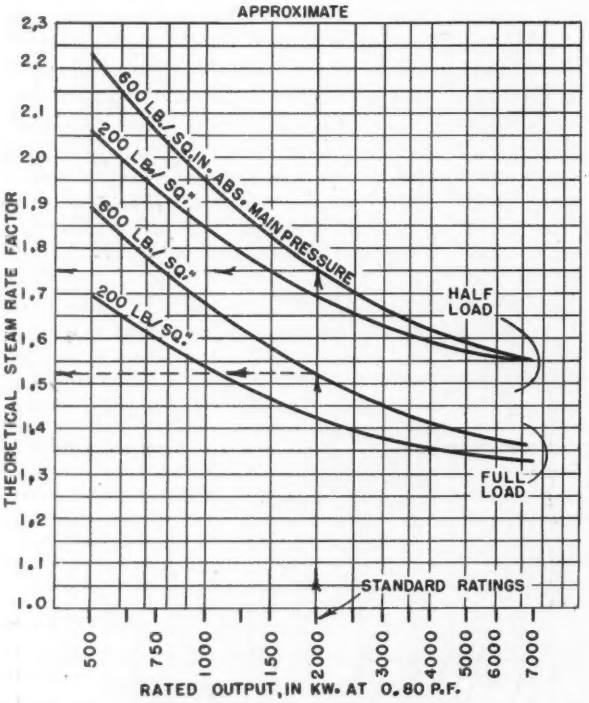


Fig. 5. Steam rates of Noncondensing Turbine Generator Sets. Full load steam rate in lb. per kw.-hr. = theor. S. R. × theor. S. R. Factor. Half load steam rate in lb. per kw.-hr. = theor. S. R. × theor. S. R. Factor.

The steam conditions for these examples, with one exception, were all on the same basis as the charts Figs. 1 and 2. Suppose that the exhaust pressure instead of being given as a pressure were expressed as a vacuum. The vacuum can be converted to pressure by simply subtracting the vacuum from the barometer reading. Thus, the 2 in. Hg. absolute exhaust pressure used in the examples might have been stated as a 28 in. vacuum, for, at sea level,

30 in.—vacuum, in inches Hg.=absolute pressure, in inches Hg.

In the examples the temperature of the steam was expressed as a "superheat." It could have been in terms of "total temperature" which with the help of the chart, Fig. 3, could easily be converted to "superheat." Referring to Fig. 3, it will be seen that at 200 lb. per sq. in. abs., for example, that 480 deg. F. total temperature corresponds to 100 deg. F. superheat.

On this chart, Fig. 3, "price increase" limits have been included, and on Fig. 2 the "standard ratings" within the range of the curve have been indicated by

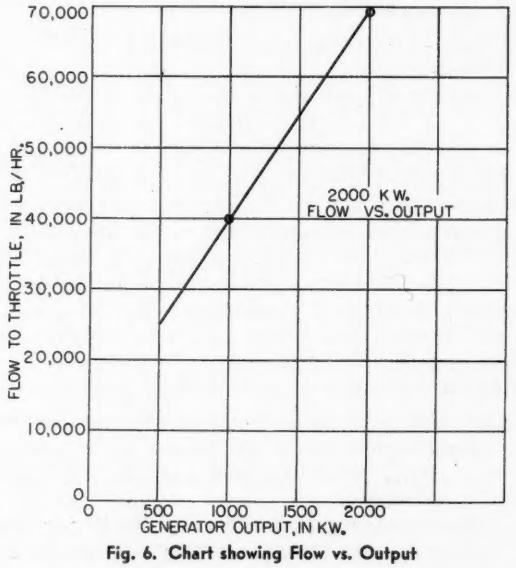


Fig. 6. Chart showing Flow vs. Output

small lines just above the horizontal scale. In tabular form the standard ratings, and pressure and temperature limits are:

Standard Ratings in kw. at .8 P.F.		Standard Main Pressure Limits in lb. per sq. in. G.	Standard Temp. Limits, in deg. F.
500	3000		
625	3500	0 to 450	750 and below
750	4000	451 to 650	751 to 825
1000	5000	651 to 850	826 to 900
1250	6000	851 to 1450	901 to 950
1500	7500	above 1450	
2000			
2500			

Prices for turbines are increased when the pressures or temperatures go from one range to a higher range. It is therefore to the purchaser's advantage in buying new equipment to tend towards the upper level of pressures and temperatures in each price bracket, so that maximum economy with minimum investment will be assured.

Approximate Steam Rates of Noncondensing Turbines

Steam rates of multi-stage noncondensing turbine generator sets may be estimated as easily as the condensing steam rates by using the charts, Figs. 4 and 5. The appearance of the theoretical steam rate chart, Fig. 4, is not the same as the corresponding Condensing Chart, Fig. 1, but it is no more difficult to use. To obtain estimated full and half load steam rates of noncondensing turbines it is only necessary to read the theoretical steam rate from Fig. 4 and multiply it by

the factors read from Fig. 5. Here again, in not over a minute's time the steam rates can be quickly estimated without laborious calculation.

To illustrate how easily steam rates can be estimated let's take an example in which all of the steam conditions are expressed in terms other than those used for the charts. Assume that steam rates are required for a turbine designed for these conditions.

Rating:—2000 kw., .8 P.F., 2400 v.
Steam Conditions
600 lb. per sq. in. gage, 700 deg. F.T.T., and
125 lb. per sq. in. gage exhaust pressure.

Referring first to Fig. 3, the steam conditions can be converted to the same basis as the curves, Thus,
600 lb. per sq. in. gage = 615 lb. per sq. in. abs.
700 deg. F. total temp. = 211 deg. F. superheat
125 lb. per sq. in. gage = 140 lb. per sq. in. abs.
The steam rates are now determined by:—

$$\text{Ratio of Inlet to Exhaust pressure} = \frac{615}{140} = 4.4$$

Load	T.S.R.	T.S.R. Factor	Est. Steam Rates, in lb. per kw-hr.
2000 kw.	22.9	1.52	34.8
1000 kw.	22.9	1.75	40.0

The question may be asked, "how about the steam rates at the other loads?" They are not difficult to determine. Probably the easiest way is to draw a curve of output versus total flow (not steam rate), for this is substantially a straight line. Such a curve would look like Fig. 6 and from it the ¼, and ¾ flows could be read and steam rates determined by dividing the flow by the output. The resulting tabulation would look like this:

Load in kw.	Steam Rate in lb. per kw-hr.	Throttle Flow † in lb. per kw-hr.
2000*	34.8*	69,600
1500	36.5	54,800 (read from curve)
1000*	40.0*	40,000
500	50.4	25,200 (read from curve)

This flow vs. output curve is approximately a straight line because, at constant steam conditions, output changes directly with the weight of steam flow, except as modified by the efficiency.

Limitations of Charts

The series of Charts, Figs. 1 to 6 inclusive, may be freely used for estimating the performance of new condensing and noncondensing multi-stage turbine generator sets of usual commercial efficiencies with a maximum error of not exceeding about 10 per cent when

1) the turbines are not of the automatic extraction type.
2) the turbine is operated with the same steam conditions for which it was designed.
3) the generator is standard 60 cycle or 50 cycle, rated in kw. at .80 power factor (geared, direct current sets are about 5 per cent poorer than 60 cycle sets of the same rating).

The basis of these charts is that the theoretical steam rate divided by the efficiency is equal to the actual steam rate. However, instead of dividing by the efficiency, the reciprocal of efficiency (theoretical steam rate factor) was plotted in Figs. 1 and 4. Then instead of "division" the slightly easier process of "multiplication" is used to obtain steam rate.

The efficiencies on which the curves are based were averaged from many recent guarantees. But it should be especially noted that efficiency of any turbine is not solely dependent upon its rating and main pressure. Rating and main pressure are only two of many factors acting to increase or decrease the efficiency. For example, an increase in superheat over any base value improves efficiency in addition to providing more energy available for power. Likewise, changes in exhaust pressure affect the efficiency.

If all of the factors affecting the efficiencies were taken into account several days would normally be required to calculate the efficiency of each turbine considered. By increasing the permissible error to reasonable limits tremendous savings in time can be realized, and it is on this basis that the present charts were figured.

The theoretical steam rate charts were based on available energies read from the steam chart. (It will be recalled that, TSR, in lb. per kw-hr. is equal to $\frac{3413}{\text{available energy, BTU per lb.}}$) but even though both charts, Figs. 1 and 4, were based on the same source they do not have the same appearance. Figure 1, the condensing chart, covers a range of theoretical steam rates varying from 7 to 13, and may be plotted in a simple form which could not be used for the noncondensing chart. Figure 4, the noncondensing chart, covering a range of theoretical steam rates varying from 10 to over 60 required a different form which could have been used, however, for Fig. 1. But the form in which Fig. 1 was plotted is slightly easier to use than the form of Fig. 4, making it possible to obtain added simplicity by sacrificing some consistency of appearance. But both charts are unique in form and easily usable.

It was pointed out in the first paragraph of this article, that, for every dollar spent for a condensing turbine generator set, another dollar would probably be spent each year to keep it supplied with steam. Efficiency is so important that most purchasers could not afford to operate continuously an inefficient condensing turbine even if the turbine were originally given to them without charge.

The heat energy remaining in the steam exhausted from noncondensing turbines is ordinarily used instead of being discarded as it normally is from condensing turbines. But if the efficiency of the noncondensing turbines can be improved it frequently happens that they can develop additional power at low cost which otherwise might be furnished at higher cost by condensing turbines. Then, too, the steam flows to noncondensing turbines are sometimes enormous, amounting in many cases to the turbine being required to pass *every hour* a weight of steam equal to several times the weight of the turbine! With such great quantities of steam efficiency is important.

Preliminary studies can safely be based on the charts included in this article, but before disregarding what appears to be a small gain consult one of the specialists of a turbine manufacturer. Perhaps he can show you ways to improve the economies, resulting in more attractive evaluations.

† Throttle Flow = Load × steam rate.
* Previously Estimated.

Indicating the High Speed Diesel

Part III. Indicators are a necessity for effective Diesel operation but control of combustion is but one of the many possible uses. Different types of diagrams may be used to disclose defects in design which could be detected in no other way. A few examples of such work on different types of engines is discussed below and the effect of changes made to improve conditions shown by actual cards.

By E. T. Vincent,
Chief Engineer, Diesel Division,
Continental Motors Corp., Detroit, Mich.

INDICATORS give a record of the changes of pressure and volume of the working medium contained in the engine cylinder. The record can indicate many things of great help to the engineer if the correct interpretation be given the results. It is perhaps rather natural that the first instinct in inspection of an indicator diagram is to examine the combustion period of the cycle. Of course this is a very important phase, but actually is of very little use to us unless the engine is in very poor condition. It will, for example, show immediately if the spark advance of a gasoline engine or the injection of a Diesel engine is too late. In the Diesel cycle it is usual to put a limit on the maximum cylinder pressure to conform to the design limitations. The diagram will show if such limitations are being met. Too early an injection will result in too high a maximum cylinder pressure.

Diagrams from all cylinders of a multi-cylinder engine will indicate if the engine load is equally distributed between the various cylinders, an important consideration in successful maintenance of any Diesel engine. In addition, by direct measurement the approximate compression pressures can be checked and compared with valves when the engine was new to obtain data regarding the condition of piston and rings. Leaky valves are also indicated by low compression pressures but serious leakage from a valve will usually show up rapidly by a burned seat and failure of that cylinder.

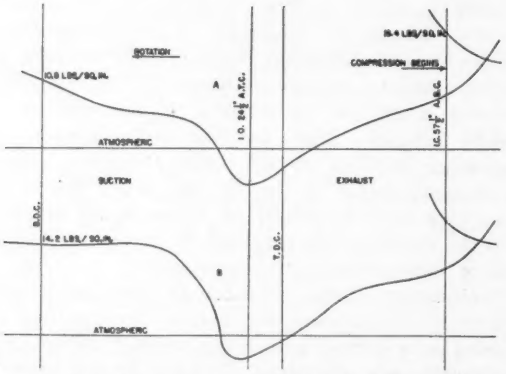


Fig. 11. Card A, taken from a 2500 r.p.m. supercharged gasoline engine showed restrictions to the air flow which, when corrected, gave an increase of 3 per cent in power and Card B

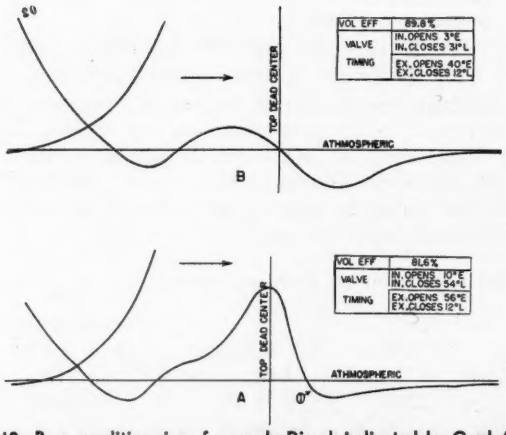


Fig. 12. Poor conditions in a four-cycle Diesel, indicated by Card A, at T. D. C. were corrected by proper valve timing to give Card B and an increase of 8.2 per cent in volumetric efficiency

So much for the more or less obvious faults shown by indicator diagrams. The real value of such diagrams is in revealing defects and differences not associated with the combustion end of the cycle. This type of defect can have far more influence on the resulting engine performance than the more obvious defects of the combustion period.

Consider for a moment the gasoline engine cycle. Here we have a charge of fuel and air in the cylinder at the beginning of compression. This is then compressed up to the point at which the spark ignites the charge. Combustion proceeds at a definite rate, depending upon the design of the cylinder head, amount of turbulence, etc. A definite indicator card is obtained which can only be changed by change of spark advance, so the indicator for the sole purpose of checking combustion is not very important. By modifying valve timing, port areas, manifolding, etc., however, the cylinder charge can be varied and the power output increased and fuel consumption reduced. The indicator, if used correctly, will give clues to the type of change necessary to obtain maximum engine performance. An example of the use of an indicator for such work is shown in Fig. 11. A & B taken from a supercharged single cylinder aircraft engine at 2500 r.p.m. In diagram A it will be observed that the pressure of the charge at beginning of compression is 18.4 lb. per sq. in. while in B it is 19.25 lb. per sq. in. This change secured with small changes to the manifolding increased the engine output of a little over 3 per cent.

During the suction stroke in diagram A the pressure is always well below that of the supercharge pressure of 15 lb. per sq. in. At bottom dead center (B. D. C.) the cylinder pressure was only 10.8 lb. per sq. in. but due to ram effect this was increased near inlet closing (I. C.) to 18.4 lb. per sq. in. The pressure difference, as shown

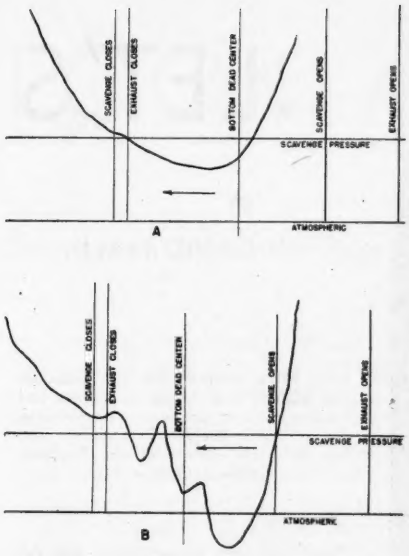


Fig. 13. Light spring cards from a two cycle oil engine. Card A shows how restricted exhaust port area caused a blow back of burnt gases into the scavenge manifold. Card B shows this condition corrected with the cylinder pressure down to the scavenge pressure when the air inlet opens

by the indicator diagram, between the point where the supercharging pressure was measured, and, the pressure in the cylinder, immediately drew attention to the fact that there was considerable restriction between the two points indicating a possible source of power loss. This information could not possibly be obtained without the use of an indicator. By extending the use of the equipment and obtaining diagrams from different points of the inlet manifold serious restrictions can be located and an intelligent correction applied.

Figure 11B shows the result of such correction. It will be observed how the cylinder fills to a pressure close to that of the supercharge pressure while the ram effect still persists and carries the pressure at inlet closing to almost 1 lb. per sq. in. higher than formerly. This resulted in the increased power already mentioned.

In the case of multi-cylinder engines, a great deal can be learned by indicating not only the cylinders but also the intake and exhaust pipes. In the case of a 12 cylinder V-Diesel engine, indicated some years ago, one of the causes of poor performance was located in the manifolding of the exhaust pipes. Diagrams, from all the points mentioned, revealed a pressure wave set up by the exhaust from one of the cylinders affected the air charge of another cylinder which was at the beginning of its intake stroke with both valves open. As a result this cylinder started its suction stroke with exhaust gas at a pressure of several pounds per square inch above atmosphere from back flow through the exhaust manifold. Until this gas had been expanded to below atmospheric pressure, obviously, a new air charge could not be drawn in. This defect would not be revealed by a combustion diagram since the total charge in the cylinder gave the expected compression pressure and the fact that possibly 40 per cent of it was exhaust gas would not be indicated.

The indicator diagrams of Fig. 12 illustrate the use of the indicator in analyzing valve timing. By obtaining light spring diagrams the valve actuation can be accurately studied. These diagrams were taken from a four cycle Diesel engine. The valve timing changes are recorded on the diagrams and the changes in shape and volumetric efficiency are shown.

It should be noted that in diagram A considerable pressure existed in the cylinder at top center. This exhaust gas must re-expand to the point 1 before air can be drawn into the cylinder, hence the possible volumetric efficiency is reduced considerably. By changing the valve overlap and exhaust conditions, the pressure line was made to pass through atmospheric pressure at top dead center as shown in diagram B.

Volumetric efficiency of this same engine was also improved by shifting the point of closing of the inlet valve. In diagram A there is a long dwell after bottom dead center with the cylinder almost full of air. In other words, the cylinder volume decreases while the pressure remains constant which means that the charge was being pushed out through the open intake valve. By closing the inlet valve 20 to 25 deg. earlier, an additional weight of air was trapped as is indicated by the increased volumetric efficiency from 81.6 to 89.5 per cent. Here again it is seen that a good indicator gives the correct changes immediately, eliminating expensive hit and miss procedure.

Figure 13 shows light spring cards taken from a two-cycle oil engine and indicates the influence of port timing upon the scavenging process. Card A shows that the exhaust pressure had not reached the scavenge pressure when the air inlet opens resulting in blow back of exhaust into the scavenge manifold. Increased exhaust port area is obviously desirable. Card B shows the effect of changing this condition resulting in a reduced scavenge pressure for a given air flow which of course means reduced power absorbed in the scavenge pump.

(Continued on Page 751)

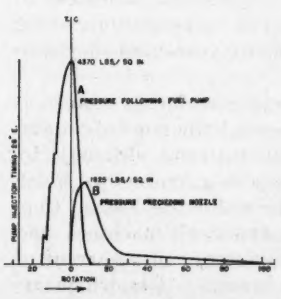


Fig. 14. The indicator is also useful on the injection system. These diagrams show a loss of approximately 2500 lb. per sq. in. between the fuel pump Card A and the atomizer Card B

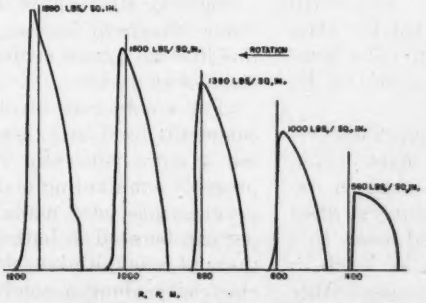


Fig. 15. Effect of engine speed upon fuel injection pressure and timing when using an open nozzle. This effect complicates optimum variable speed operation

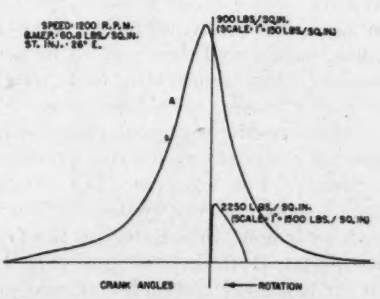
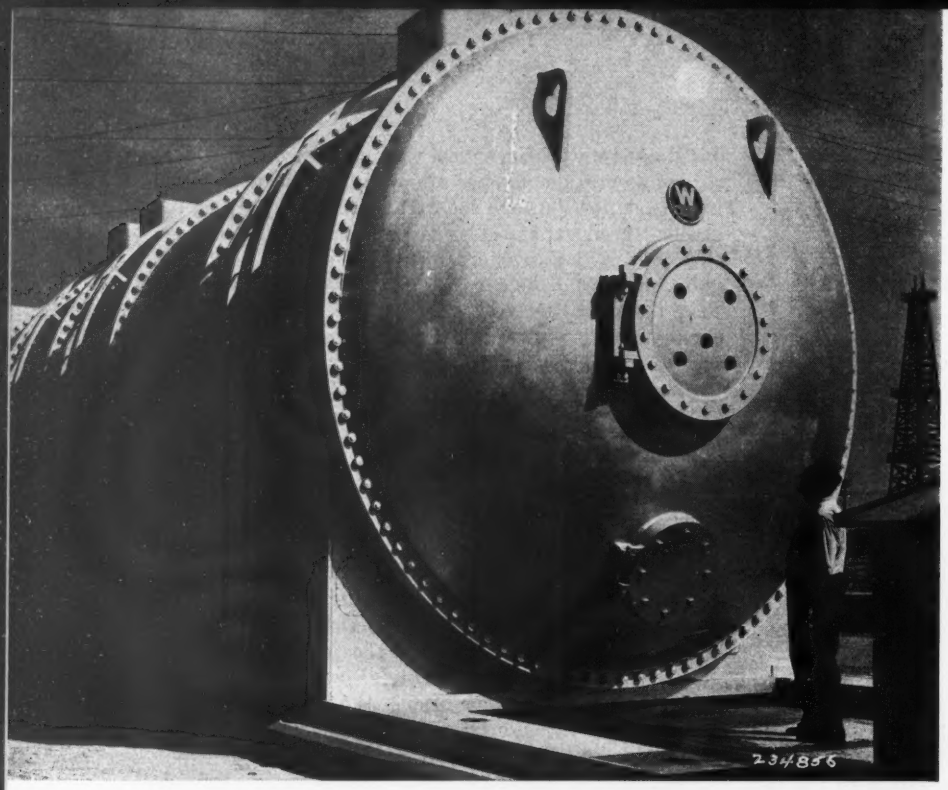


Fig. 16. Fuel injection diagram superimposed on combustion diagram A. Combination cards of this kind often bring out interesting points

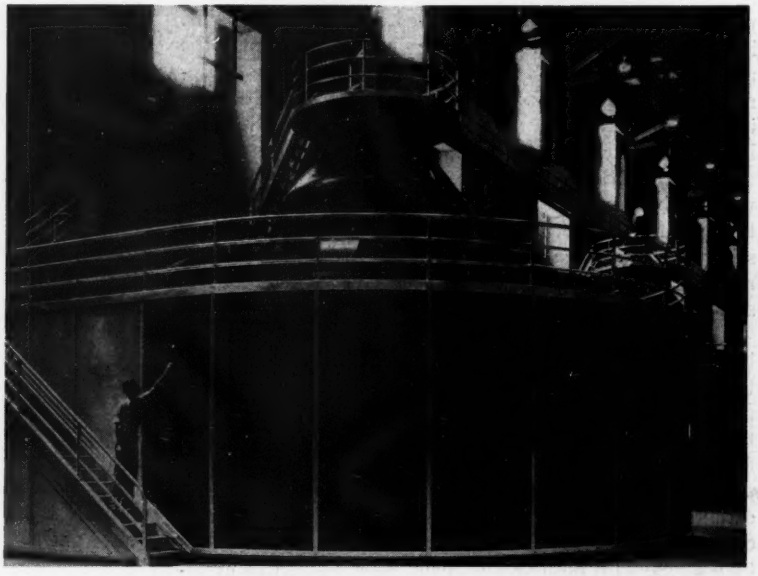


LET'S

BY
DAVID HALL

Left: More than 96 per cent efficient this 60,000 kv-a. hydrogen cooled frequency changer provides a tie between the 60 cycle Boulder Dam system and the 50 cycle system of the Southern California Edison Co.

Below: At unity power factor and full load, this 82,500-kw. Boulder Dam generator is 96 per cent efficient



EFFICIENCY, as applied to electrical machinery, means something very definite. It is a measure of the losses—the energy which is not useful. A kilowatt-hour which is lost costs just as much to produce as a kilowatt-hour which is useful. The slightest knowledge of fundamental law informs us that all active machinery must have losses, otherwise the output from a machine would equal the input and we would have perpetual motion. Notwithstanding this fact, the true efficiency of large, modern electrical machinery is amazingly near to 100 per cent.

Examples of very high efficiency of equipment built may serve to emphasize this point. The 60,000-kv-a., 50/60 cycle frequency changer recently put into operation by the City of Los Angeles, has an overall efficiency over 96 per cent. The 65,000-kv-a. transformers furnished to the City of Los Angeles and installed at their Station "B" which will be used for receiving power from the Boulder Dam Lines, have an efficiency of 99.46 per cent. The large Boulder Dam generators, each weighing 2,000,000 lb. have an efficiency of 96.9 per cent.

These results represent progress in design, improvement in materials, and better fundamental ideas in construction. For example: The frequency changer referred to is entirely enclosed. The enclosure is filled with hydrogen, thus reducing the frictional losses to a minimum. Hydrogen weighs only 1/13th as much as air; it is a good conductor of heat and possesses other advantageous features for this particular application. Consequently, there are numerous instances where important rotational machines have been entirely enclosed and the enclosures filled with hydrogen instead of air. This construction almost eliminates air frictional losses.

Special alloys have been introduced into steel to reduce magnetic losses. Research investigations along this line have been made for many years and they continue to be made.

For conductors in electrical machinery, copper is commonly used, and there appears little hope of obtaining a more generally suitable material although by properly subdividing and transposing conductors, much progress has been made in the reduction losses. Copper can be used in both large and small machines, and there is a definite law that the passage of a current of electricity along a conductor creates a loss which exhibits itself as heat.

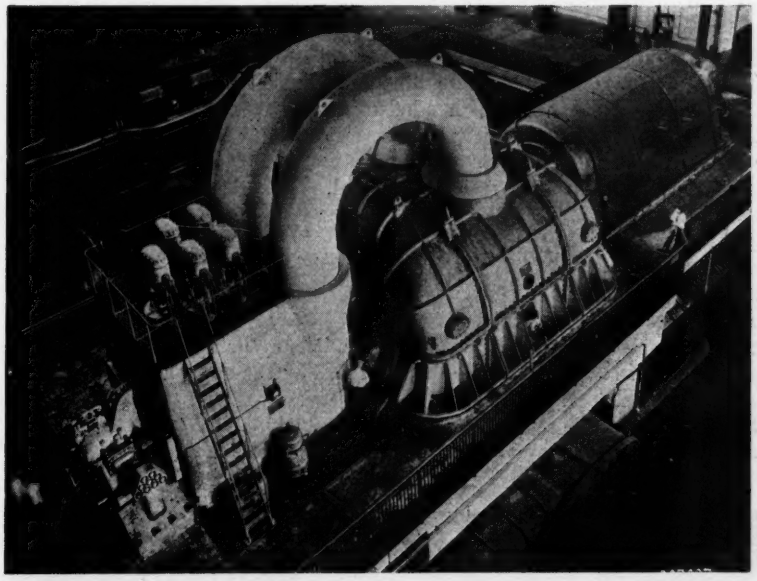
The question might naturally be asked as to whether similar improvements can be made in the efficiency of small electrical machinery. It is true that better steels are being used and improvements are still being made

LOOK AT EFFICIENCY

Engineering Supervisor, Westinghouse Electric & Manufacturing Co.

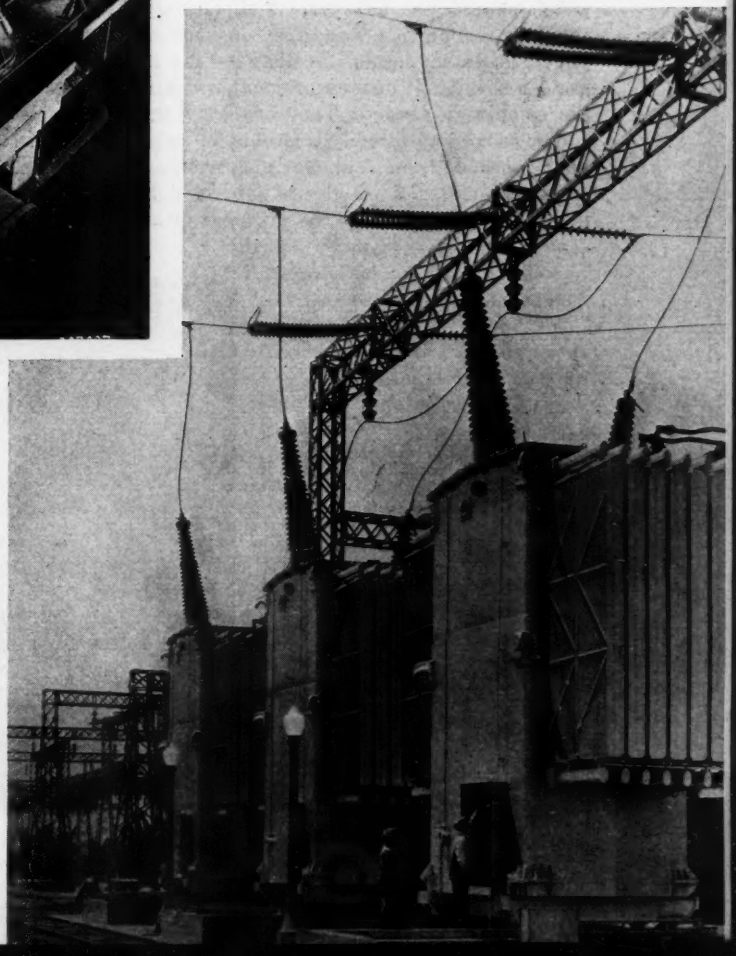
by refinements in design. Fundamentally, large machines can be made more efficient than smaller machines, but better steels and special arrangements of copper conductors are being introduced into smaller, as well as large, machines with the results that the losses in a given size unit are being reduced step by step. Some examples of characteristic efficiencies are as follows:

A one thousand horsepower, synchronous motor can be built to have an efficiency of 95.5 per cent. A hundred horsepower induction motor can be made with an efficiency of 91 per cent. A ten horsepower standard motor may have an efficiency of 88 per cent.



Left: The full load efficiency of this 165,000-kw. generator including bearing, blower motor and exciter losses is 98.7 per cent

Below: These three 275,000 v. 65,000 kv-a. autotransformers at Los Angeles are 99.46 per cent efficient



There is an old saying to the effect that all electrical machinery is made of steel, copper and insulation; to this statement there should be added one more important ingredient—"brains." Isn't it interesting to think how steel, copper and insulating material together with brains, can be made into so many forms and devices which are so useful to mankind, and which differ so much in their inherent characteristics? Out of these simple ingredients there are made various forms of electrical machinery, such as transformers, generators, motors, regulators and many other kinds of electrical equipment having wide variations in capacity, voltages and speeds.

Factors Producing Losses

For clearness of understanding, we might consider the factors which produce losses and prevent electrical machinery from being 100 per cent efficient. Fundamentally, there are copper losses, iron losses and in rotating machinery, there are friction and windage losses. These form the main losses and, in addition, there are losses due to excitation; that is, the energy necessary to produce magnetization. To simplify our view of efficiency investigation, it is well to consider the losses as of two kinds: First, the variable losses; that is, the losses which vary with the square of the current which circulates into conductors. Secondly, there are the fixed losses; these are the iron losses, friction and windage losses, and the excitation losses. It is a fundamental fact that when the variable are equal

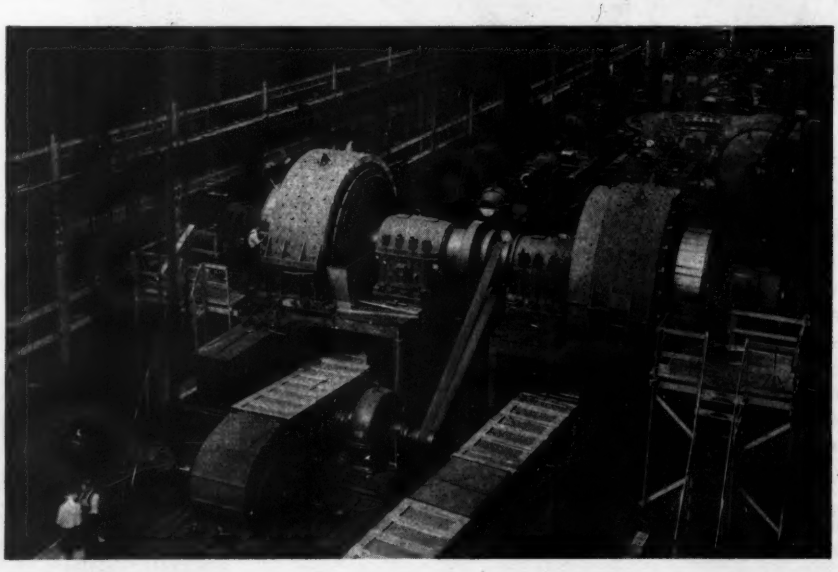
High efficiency is built into electrical machinery at the shops. Here, skilled workmen are connecting the stator winding of a highly efficient 5050-hp. synchronous motor which will drive a 3500 kw. motor generator set

to the fixed losses, the efficiency of the machine is at its maximum point. Hence it becomes possible to modify the shape of the efficiency curve by design changes. If a high efficiency is desired at light loads, the constant losses must be kept low. This is often desired on equipment that operates on low loads most of the time; for example, distribution transformers.

It is within the province of the designer to modify proportions of constant to variable losses, thus better suiting the equipment to the application. There is another fact pertaining to efficiency of electrical machines which should not be overlooked, although for many years no recognition was taken of what are commonly known as "stray losses" in electrical machinery. These are losses difficult of measurement which only occur as the machine is loaded. They are eddy currents in the copper conductors, eddy currents in pole tips and in pole faces and, in fact, eddy currents in any solid masses of material which are subjected to changes of magnetic fluxes. Today the presence of all these additional losses is recognized and the latest rules of the American Institute of Electrical Engineers require that due allowance be made for these losses so as to obtain true efficiencies, distinguishing true efficiencies from the apparent efficiency which was obtained without taking stray losses into consideration. This recognition of stray losses has led to very careful tests and investigations, which have resulted in a better understanding as to the amount and cause of such losses and how these losses may be minimized.

Expressions of Efficiency

Efficiency is usually expressed in the form of per cent. The per cent of efficiency being equal to the output of the machine divided by the output plus the losses. The output plus the losses represents the input. The losses, again, may conveniently be divided into constant losses and variable losses. These losses exhibit them-



Only rarely is it possible to test big motors and generators under full load before they leave the factory. Here two 7000-hp. motors for steel mill service are being tested against each other in the shop, one acting as a motor to drive the other as a generator

selves in the form of heat and, consequently, all electrical machinery must be provided with a means of cooling.

As a comparison, did you ever think why the motor in your automobile gets so hot? Why is it necessary to furnish a radiator and a fan on your automobile motor? Consider the great amount of lost energy which is being dissipated, and also consider the fatal results if proper provision is not made for getting rid of the heat from all electrical machinery. This is usually accomplished through the medium of air circulation; it is common practice to provide fans on the rotors to give the proper circulation of air.

In large machines it is common practice to enclose the machine and provide a means of cooling; for example, water cooling coils are used to cool the air which passes through the machine. Knowing the efficiency of a machine, it is easy to arrive at the necessary amount of cooling medium to be furnished to take away the

Ordinary induction motors sold by the thousands for industrial use are often 88 per cent efficient

heat. It is satisfactory to furnish 75 to 100 cu. ft. of air for each kilowatt of loss in an electric machine cooled by air circulation. If the machine is provided with a closed air circulation, it is common practice to supply water cooling coils for cooling the air. In this case, it is usual to supply 0.6 to 1.0 gallons of water per kilowatt loss depending on the water temperature. These figures refer to the number of cubic feet of air per minute and the number of gallons of water per minute.

Efficiency and Cost

Someone has said you cannot "have your cake and eat it too" and since efficiency is so linked with cost that they rise and fall together, it is only logical that the selling price of a given machine should be linked with its efficiency. This can best be done by evaluating efficiency, and the correct evaluation will depend upon the actual value of power associated with the equipment. In some forms of equipment this is already being done, and as progress is made in reducing losses, it is natural to suppose that eventually standard efficiencies may be recognized. While the word "efficiency" has a very definite meaning as applied to electrical machinery, it is sometimes used in a general sense to convey the idea of suitability of application and, in many cases, suitability of application may be more important than the actual efficiency as expressed by the losses. Hence, the best engineering not only takes true efficiency into consideration, but with the reduction in losses there is also an intelligent effort toward making machinery better suited to the uses to which it is applied.

As a conclusion, it can be said that the efficiency of electrical machinery is constantly receiving attention and improvement is being made through research, combined with a better and more thorough understanding of design and design proportions, yet there is a limit and as this limit is approached it becomes more and more difficult to advance and it does not seem unreasonable that efficiencies, as applied to electrical machinery, may eventually be standardized and a premium offered for efficiencies which exceed the recognized standards.

Indicating High Speed Diesels

(Continued from page 747)

As an example of the use of indicator diagrams from the injection system of an oil engine, Fig. 14 shows the throttling effect that a long small bore fuel pipe can exert. Diagram A was recorded with the indicator fitted between the fuel pump and the injection tubing while diagram B was obtained between the tubing and atomizer. It will be observed that there is about 2500 lb. per sq. in. pressure drop between the peak pressures at the two ends of the pipe. In addition, there is roughly 15 deg. timing lag between the two ends of the pipe. This lag is not of much consequence in a constant speed engine but with variable speed it will result in varying lag, which has to be corrected for, thus producing additional complication. The gradual reduction of fuel pressure at the nozzle end in the latter stages of injection should also be noted.

Diagrams of Fig. 15 show the effect of engine speed upon the injection pressure and timing when using an open nozzle. It will be observed that there is a gradually increasing lag in the point at which injection begins and a greater lag in the point at which injection ceases, while the maximum injection pressure increases very rapidly with the speed. The peak pressure is reached later as speed increases. The diagram of Fig. 15 shows an injection diagram superimposed upon a combustion diagram. In many instances such combinations of indicator cards bring out very interesting points.

It is possible to extend a discussion of indicator diagrams indefinitely, but it is believed that sufficient has been given to indicate the use to which a good indicator may be put. In the case of Diesel engines, such an instrument is an absolute necessity if control of combustion is to be secured, but, as previously pointed out, this is but one of the many possible uses

Method of handling furnaces and equipment designed for burning coals having ash with low temperature fusion point. Methods used depend upon the type of grate or stoker used.

Prevention of Clinker on Industrial Stokers

By J. R. DARNELL*

ONE OF THE most serious complaints against low grade coals is the formation of clinker. To present proper approaches to the clinker problem we must first know what it is. Clinker is ash which has been fused and then solidified. In some coals the fusion point of the ash is as low as 1800 to 1900 deg. F., while in others it may be as high as 3000 deg. F.

In most cases, the coals of the Middlewest have ash with lower fusion points than eastern bituminous coals and the most attention has been and still is being given to the clinker problem in the Middlewest. Since, normally, operators of industrial stokers in this section cannot justify the purchase of Eastern coals, when burning local coals with high furnace temperatures they find it necessary to keep the ash out of the zone of high temperature in order to avoid clinker formation.

This avoidance of clinker formation by keeping the ash below the fusion point may be accomplished in several ways, depending upon the type of grate or stoker used. Probably the best type of stoker for coals with high percentage of ash which usually have low fusion point, is the chain or traveling grate. Such a stoker may be either of the natural or forced draft type. If forced draft is used, however, the combustion rate (pounds of coal burned per square foot of grate area) must not be pushed very much beyond that obtained with natural draft in cases where the ash has a very low fusion point. The percentage of ash and its fusion point determines the optimum combustion rate and there are no arbitrary rules which may be applied.

A minimum disturbance of the fuel bed is absolutely necessary when burning coals which have a tendency to form clinker. If the ash is brought to the top of the fuel bed where the temperature is higher than at the grate surface it is only natural that clinker will form if the fusion temperature of the ash is equal to or lower than the temperature at the top of the fuel bed. Some coals have a tendency to coke or to puff up into "cauliflower" shapes. Combustion is retarded at these points and firemen often use a slice bar or hoe to break up such formation. This causes a disturbance of the ash and clinkering usually results.

*Consulting Engineer, Jenkins Petroleum Process Co. and Donnelly Process Corp.

Tempering the Coal Lessens Clinker Formation

Coal that has been properly tempered will burn completely with less excess air, with less clinker formation and with lower ash pit loss than coal that is too dry. This applies to the operation of all methods of fuel bed firing—hand firing, underfeed and overfeed stokers as well as traveling grate stokers.

Coal is properly tempered when its surface moisture content is increased from 2 to 5 per cent, uniformly throughout its entire mass. Since time is a necessary factor, tempering is best accomplished by adding water at the time the coal is put into storage or into the bunkers. Properly designed sprays above the conveyor not only add the water in small increments but the tumbling action of the coal from the conveyor belt or buckets into the bunker assures uniform distribution. Some concerns prefer to buy run of the mine coal and then do their own crushing and sizing. Adding the proper amount of water at the crusher insures uniform distribution. T. A. Marsh[1] says that the steam formed from the moisture in coal does not cause the particles to burst open but the formation of steam between the particles probably prevents the binding action of coal tars. This action of the steam keeps the fuel bed more porous, permits more uniform distribution of the air and because of its high specific heat undoubtedly helps to cool the ash below its fusion point, provided of course that it is not disturbed and is allowed to settle to the grate surface.

Mr. Marsh says that considering 3 per cent as a fair average of the moisture required to temper coal properly, the heat loss to the chimney due to the added moisture is low. Even if 5 per cent moisture were added the loss would be not more than ½ of 1 per

[1]T. A. Marsh—Combustion In The Power Plant—(Combustion Publishing Corp.—1924)

cent. The advantage derived from tempering are many times this figure.

Although the sizing of coal is not the greatest single factor in the prevention of clinker yet its importance should not be neglected. The necessary amount of moisture for proper tempering cannot be uniformly distributed unless the coal is properly sized. In general, fine coal can be burned with better results than when it is too coarse but the uniformity of particles is the most important item in the sizing of coal. For natural draft chain grate stokers 1¼ in. screenings often are specified but the percentage of fines sometimes is so great that when the coal is discharged into the stoker hopper from the bunker the large particles roll to the outside and the fines settle in the middle. The larger particles allow more air to pass through and burn more rapidly. The rate of burning is so rapid that the ash is exposed to the radiant heat of the side walls and the arch. This intense heat fuses the ash and excessive clinker formation along the sides is inevitable.

Recirculated Flue Gas

Going back over a period of many years we find a large number of patents which have been granted covering the use of recirculated flue gas to consume smoke and unburned gases either by introducing the returned gas through ports above the fire or into the ash pit beneath the fire. Recently it was suggested that the latter method might also help to prevent the formation of clinker but it should be remembered always that the major portion of all flue gas is carbon dioxide and nitrogen neither of which will support combustion and in addition actually retard combustion because they envelope the combustible particles in the fuel so that the oxygen finds it more difficult to combine with carbon and combustible gases. In other words, carbon dioxide and nitrogen are good fire extinguishers.

If any one ever found that the recirculation of flue gas was beneficial in retarding clinker formation in boiler operation it probably happened that the waste gases were recirculated by means of a steam jet. The steam of course would function in the same manner as has been previously explained when tempered coal is used. But why spend money to blow inert gases through the fuel bed to retard combustion when steam or water vapor in moderate amounts may be used without the ill effects of recirculated gases?

In cases where the coal has ash with exceptionally low fusion point, the water added by tempering may not be sufficient to prevent clinker formation. In such instances it may be advantageous to mix steam with the air being supplied for combustion or if steam is not available, as may be found with heating boilers of the hot water type, a fine spray of water may be suspended in the air duct.

As a matter of general interest the reader's attention is called to U. S. patent 829,105 issued to H. L. Doherty in 1906. So far as my search has extended, Mr. Doherty is the only one of several hundred inventors, dealing with the recirculation of flue gas, who has dealt with the effect of the recirculated gas on clinker formation. One of the objects of Mr. Doherty's invention was "to prevent or minimize the formation of clinkers in the furnace".

As shown in the patent, however, the furnace was of the gas producer type and was used to heat the retorts in a coal-gas bench. The heating problem, thereafter, was very much different from that found in steam boiler practice.

In heating a coal gas bench, there must be mild uniform heating to prevent overheating of the coal and cracking of the tar inside the retorts, whereas in steam boilers the water absorbs heat as rapidly as it is applied to the outside of the tubes.

As described in the above patent, recirculated flue gas is discharged through a very thick fuel bed and the CO_2 content of the flue gas is reduced to CO. This endothermic reaction absorbs heat and maintains the temperature of the fuel bed at a point at which clinkering will not occur. The carbon monoxide arising from the fuel bed is burned with a much milder heating effect than would give satisfactory steam production in boilers. The best designs of steam boilers utilize as much as possible the radiation from the fuel bed, whereas in the Doherty patent the retorts are almost entirely shielded from direct radiation and besides the fuel bed is kept at much lower temperature than in good boiler practice. Furthermore the fuel bed is much thicker than is found in boiler practice. Too thick a fuel bed is one of the causes of clinker. Doherty's observation, however, might furnish the basis for further research on this subject. His comments on conditions necessary to prevent clinkering are interesting:

"This temperature at which clinkering commences to form varies from about 1500 deg. F. to about 2300 deg. F., depending upon the character of the fuel and the amount of iron and silicon therein. I have found that a mixture of about 4 per cent CO_2, 16 per cent free oxygen, and 80 per cent free nitrogen at temperature of about 600 deg. F. is suitable for carrying out my improved process with a certain character of fuel which clinkers at a high temperature, and another mixture of about 10 per cent CO_2, 10 per cent free oxygen, and 80 per cent free nitrogen at a temperature of about 700 deg. F. has also been found suitable with another character of fuel which clinkers at a much lower temperature. The higher the temperature of the gaseous mixture admitted beneath the fuel-bed the larger should be the proportion of CO_2 in the mixture, which is necessary to keep the temperature of the fuel-bed below the clinkering-point. I have found that the mixture of CO_2, free oxygen, and free nitrogen operates satisfactorily if injected at a temperature of from 600 deg. F. to about 800 deg. F., in which case heat is given up to the gas from the fuel and clinkers are not formed."

Foreign Materials Affect Clinker Formation

Almost every boiler fireman probably has noticed that when refuse such as newspapers, magazines, books, wood scraps, rags or perhaps garbage, is thrown on the fuel bed, clinkering to a much greater extent will occur than when coal alone is burned. In a paper read at the Second International Conference On Bituminous Coals held at the Carnegie Institute of Technology in Pittsburgh in 1928, Langtry[2] and Kohout

[2]W. D. Langtry and J. F. Kohout—Fusing Point of Ash From Mixtures of Coal and Foreign Materials.

gave the results of tests made on the fusion temperature of samples of coal ash, garbage ash and mixtures of the two kinds of ash. It was found that the fusing temperature of the mixture was lower than that of either of the constituents. In one example the fusion temperature of the coal ash was 2678 deg. F. and that of the garbage ash was even higher, being 2862 deg. F. But the fusion temperature of the mixture was only 2294 deg. F. In another case the coal ash fused at 2539 deg. F., the garbage ash at 2862 deg. F., and the mixture at 2185 deg. F. All tests were made with mixtures of 90 per cent coal ash and 10 per cent garbage ash. The authors state:

"It would be reasonable to assume that if even a smaller percentage of garbage ash were mixed with coal, the fusion temperature might even be lowered to a greater extent."

Research chemists some day may find a simple chemical which when mixed with coal will raise the fusion temperature of the ash sufficiently to permit the use of any type of stoker for low grade Midwestern coals.

Operators of stokers for boilers and other industrial furnaces should study the characteristics of the coal they contemplate purchasing before contracts are signed. Bulletin 22 of the U. S. Bureau of Mines gives analyses of coals by seams and localities in every state in the Union where coal is found while Bulletin 209—Fusibility of Ash From Coals Of The United States gives the percentage of ash and its fusion temperature for these same coals. The highest average fusion temperatures are found in Pennsylvania, Maryland and Virginia where in some cases the maximum exceeds 3000 deg. F., while the lowest values are found in Illinois, Indiana and parts of Oklahoma and Missouri. In these states in some localities the average fusion temperature is about 1950 deg. F.

In the Pacific North West where sawdust and hogged fuel are burned on stationary grates it has been found necesary to provide water cooled grates to prevent clinker formation. Water is circulated through hollow grate bars which may be in the form of castings or fabricated from tubing or pipes.

One large underfeed stoker company has developed water cooling means for the tuyéres and overfeed section of a multi-retort stoker used in a central power station in Iowa.[3] Recently it was reported that combustion rates approaching 50 lb. per sq. ft. of projected grate area had been attained at this station, burning coal from an Illinois strip mine, with ash having a fusion point of about 1900 deg. F.

Water cooling will also permit burning petroleum coke or stokers. This fuel has no clinker problem but the almost total absence of ash leaves no protection for the grate surface and the intense heat burns up the iron as well as the coke.

De-Ashing Process Too Expensive

It has been suggested that clinker troubles might be minimized or made negligible by removing a major portion of the ash. The Trent process removes two-thirds to three-fourths of the ash but it is expensive and has not found favor in this country. The coal must first be pulverized and then after being mixed with water is agitated with a non-viscous oil. This causes the combustible material to form a floating amalgam with the oil while the ash remains suspended in the water below. The de-ashed coal must then be dried if it is to be burned in pulverized form or if it is to be used on stokers or stationary grates it must be made into briquettes by binding with pitch.

[3]Design and Development of A Water-Cooled Underfeed Stoker —J. S. Bennett and C. J. Herbeck, Mechanical Engineering. Vol. 57, pp. 761-765, D '35.

Unit Heater Standardization

AFTER A YEAR'S study of field conditions and conferences with the Bureau of Standards, the Engineering Committee of the Industrial Unit Heater Association presented its report on the "Standardization of Unit Heaters of the Propeller Type". The report outlined two proposals (a) the elimination of unnecessary sizes of units and (b) the publishing of more precise data covering performance. The members adopted the following broad program to be effective not later than June 1, 1938, with the understanding that further study on standardization would be continued.

Recommendation No. 1 on Sizes of Units was that no manufacturer is to make or list more than 25 sizes between the limits of 15,000 to 350,000 B.t.u. A unit size is defined as a combination of a certain heating element with a certain propeller type fan and a certain speed motor, the combination to be rated at its maximum 60 cycle operating speed. Rating to be at 2 lb. steam pressure and 60 deg. F. entering air, in accordance with the code for testing and rating unit heaters. The maximum final temperature of the air leaving the unit at the basic rating is not to exceed 135 deg. F.

When this same combination of heating element and fan is equipped with a lower speed motor, it is not considered a new size. When the same combination of heating element and fan is supplied with a decorative, or so called Deluxe, casing or a peculiarly shaped casing in such a manner so as not to affect the basic rating, it is not considered a new size. When the heating elements, or fan, or both are changed so as to alter the basic rating then it is considered a new size unit.

Recommendation No. 2 on Warranted Operating Pressure and Temperature was that price sheets and tables of each manufacturer are to state prominently the guaranteed steam working pressure and temperature.

Recommendation No. 3 on Ratings in Accordance with Standard Test Code was that manufacturers shall consult the Standard Test Code and include in their ratings such values as are specifically called for in the Code.

Recommendation No. 4 on Outlet Velocity was that rating tables of each manufacturer state the outlet velocity measured at the final temperature of air in accordance with a standard formula. The velocity in feet per minute shall be determined by dividing the cu. ft. of air per minute measured at the final air temperature by the net area of the outlet opening in square ft., less 7½ per cent to compensate for obstruction due to outlet louvres.

Recommendation No. 5—Effective Date. Entire program to become effective not later than June 1, 1938.

Carnegie-Illinois Steel Corp. building No. 5 Power Station at its South Works in Chicago. Three 300,000 lb. per hr., 475 lb., 750 deg. F. boilers, 25,000-kw. turbo generator, three 75,000 c.f.m. turbo blowers, two 50,000 lb. per hr. industrial evaporators installed.

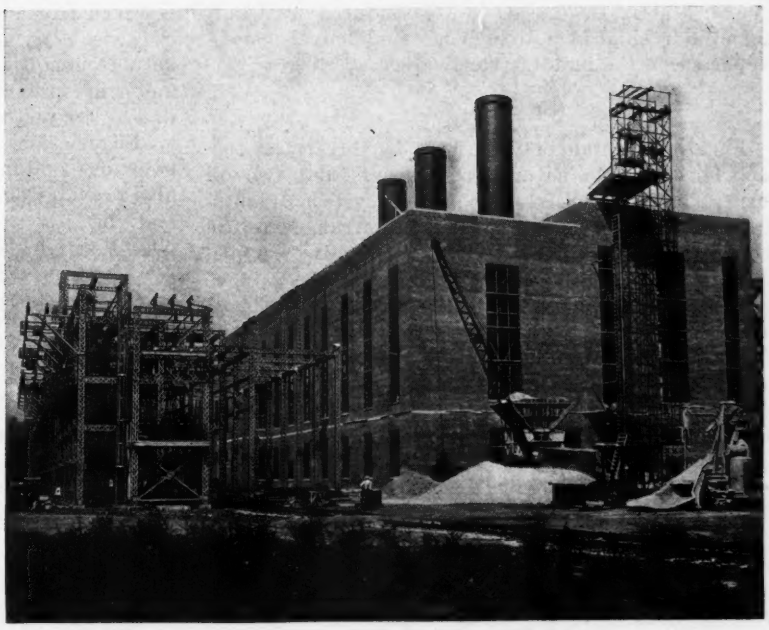


Fig. 1. Recent view of the new station as it neared completion

STEEL MILL Increasing Power Facilities

ONE OF THE IMPORTANT industrial power plants of the year is being built at the South Works of the Carnegie-Illinois Steel Corp. in Chicago and is expected to be in preliminary operation sometime after the first of the year. Three 300,000 lb. per hr. boilers operating at 475 lb., 750 deg. F. will supply steam for three 75,000 c.f.m., 30 lb. ga. turbo-blowers, one 25,000-kw. turbo generator and a battery of industrial evaporators with a total capacity of 100,000 lb. per hr. of 160 lb. steam for general plant use. Provisions for expansion anticipate the installation of a 50,000-kw. unit in the future, significant of the tendency of industrial plants toward capacities comparable with central station practice.

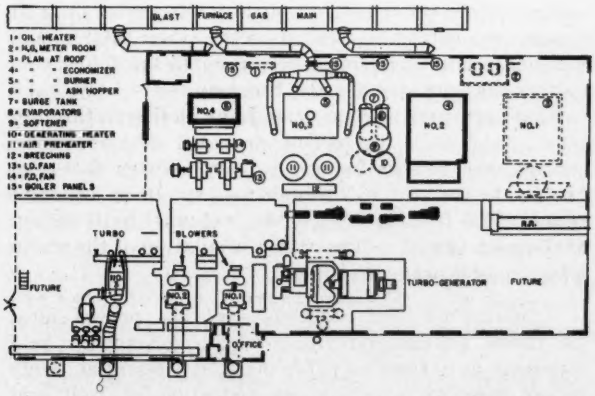


Fig. 2. The station is about 125 ft. wide, 88 ft. high, with a maximum length of 275 ft. and covers an area of over 30,000 sq. ft.

By-Product Fuel

The new plant, No. 5 Power Station, will allow a more efficient utilization of by-product fuel and provide means for shifting from one auxiliary fuel to another in accordance with market price. Blast furnace gas available after the needs of the metallurgical furnaces and gas engines have been taken care of will be used as a primary fuel. For the present, natural gas and oil will be used as secondary fuels. Connection has already been made to the natural gas line serving Chicago and two 250,000 gal. oil storage tanks are in place. Provision has also been made to change over to pulverized coal whenever this step seems desirable. The yard layout and building design provide for storage, handling and pulverizing facilities.

Boilers are of the four drum bent tube type with 22,000 sq. ft. of boiler heating surface, plus an additional 6200 sq. ft. of water cooling surface in the 17,150 cu. ft. furnace. Each boiler has a 7180 sq. ft. economizer, a 6450 sq. ft. superheater, two 26,200 sq. ft. regenerative

type air heaters, two forced and two induced draft fans and an individual 14 ft. diam. concrete lined steel stack supported on the building steelwork.

Efficiencies

Furnaces are tangentially fired, by three blast furnace burners, two natural gas burners and two oil burners in each corner. A complete system of automatic combustion control is provided, arranged to fire the blast furnace gas and either of the two supplementary fuels.

Forced draft fans are rated at 45,000 c.f.m. at 11 in. of H_2O, 100 deg. F. One is driven by a 2200 v., 125 hp., 1500 r.p.m. motor, the other by a geared turbine. Induced draft fans are rated at 160,000 c.f.m., 14 in. H_2O, 540 deg. F. at 725 r.p.m. One is driven by a 2200 v., 600/300 hp., 750/500 r.p.m. two speed motor, the other by a geared turbine. Boiler feed pumps, at 3500 r.p.m., have a capacity of 750 g.p.m. each at a head of 1427 ft. Two are driven by 400 hp., 1500 r.p.m. geared motors, and each driven by a 150 hp., 3600 r.p.m. motor. A single twin steam jet vacuum pump and duplicate 750 g.p.m. hotwell pumps, each driven by a 1450 r.p.m., 50-hp. motor are provided. The turbine is bled at 40 and 80 lb. abs. for two stages of extraction heating.

Electrical control equipment will be in a separate two-story building, 67 ft. long by 32 ft. wide, which also provides offices for the load and fuel dispatchers and the power production department. Power from Nos. 1 and 5 power stations will be stepped up, and power over the corporation's 66 kv. lines from the Gary and Buffington plants will be stepped down, for distribution through the plant in a central outdoor substation.

Turbo-Blowers

Each of the three turbo-blowers is rated at 75,000 c.f.m., at 3000 r.p.m., and 30 lb. ga. maximum pressure. Turbines exhaust to individual 3850 sq. ft. single pass, divided water box condensers. Each unit has one twin

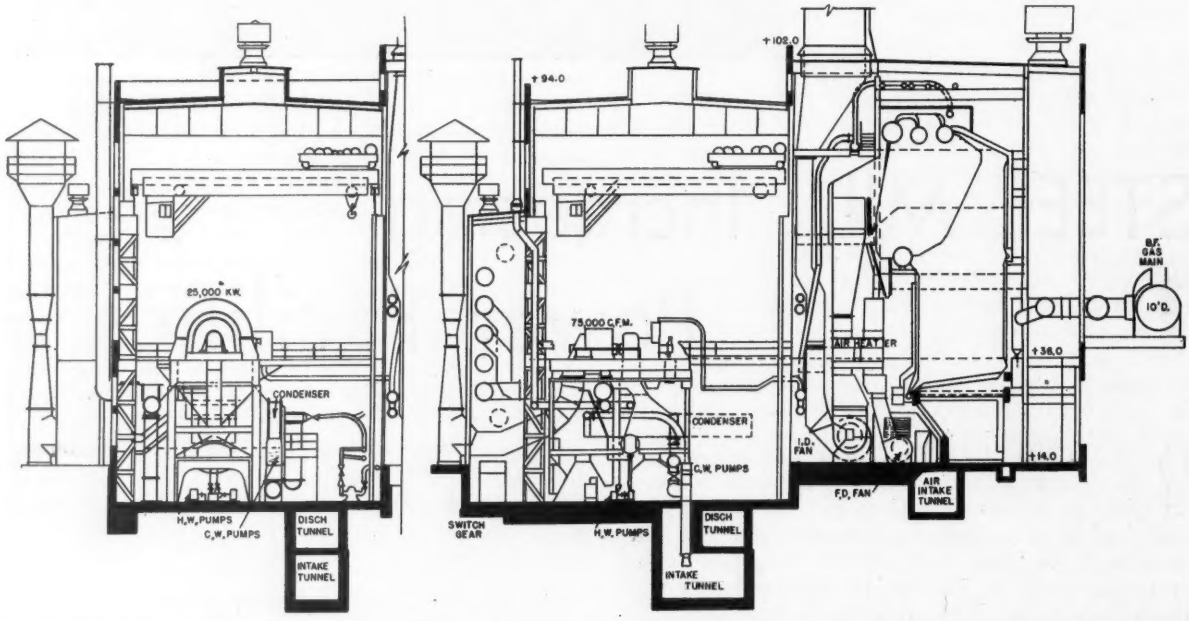


Fig. 3. Blast furnace gas is used as a primary fuel, natural gas and fuel oil as auxiliary fuels but provisions are made in the design for changeover to pulverized coal later. Boiler operation is under full automatic combustion control. Circulating water for the condensers and feedwater makeup is taken from Lake Michigan

the third by a 410-hp. geared turbine. Makeup, expected to run about 20 per cent, is taken from the lake and treated in a 29,000 gal. per hr. hot process lime and soda ash softener. A 600,000 lb. per hr. deaerating and two extraction heaters (one 2010 sq. ft., the other 1870 sq. ft.) are in the feed heating cycle. Two single effect evaporators using 450 lb. steam will supply a total of 100,000 lb. per hr. of 160 lb. steam for general plant use.

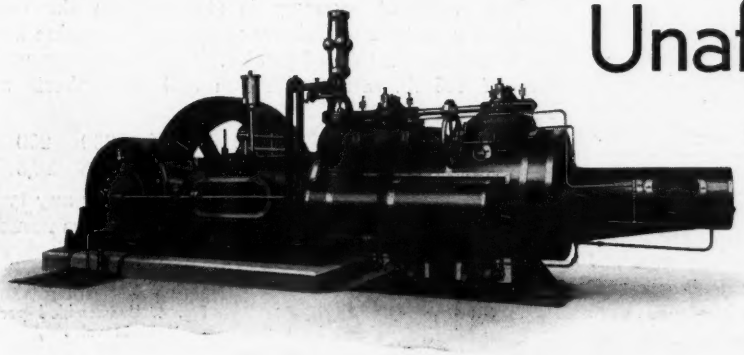
Electrical Supply

Electric power is generated at 13,200 v., 3 ph., 25 cycle, by a 1500 r.p.m., 25,000 kw. air cooled generator with a direct connected exciter. The turbine exhausts to a 20,000 sq. ft. single pass divided water box condenser supplied with cooling water by two vertical circulating pumps, each with a capacity of 19,000 g.p.m. steam jet air pump and duplicate 150 g.p.m. hotwell pumps each driven by a 16 hp. motor. Four 9700 g.p.m., vertical circulating pumps driven by 75 hp., 720 r.p.m. motors are provided for the three units.

Cooling water is taken from Lake Michigan through four intake wells, three now provided with traveling screens, the fourth for future use. Water flows by gravity to the station through a 10 by 10 ft. concrete tunnel, 1400 ft. long. A 4 by 10 ft. tunnel built on top of the main tunnel will permit recirculation of the warm water to prevent ice troubles.

Chromium-nickel stainless steel has proved ideal for valves, fittings and piping where resistance to acid corrosion, as in sulphite paper making, is essential. High tensile strength also permits reduction of wall and flange thicknesses, thus reducing cost.

Sleeve-Poppet-Valve Unaflow Engine



FOR SEVERAL years the Skinner Engine Co. has realized that there would be an increased demand for high-economy variable-speed steam engines if a simplified cut-off mechanism could be employed to make the engine practically as easy to operate as a constant-speed engine.

Heretofore the speed control for variable-speed engines was usually through cumbersome and heavy shifting gears, which required considerable physical effort to change the engine speed.

Also it was desirable that such a gear could be easily arranged for automatic control, governing the rate of flow from a compressor or pump driven by the engine, or maintaining constant pressures with varying flows.

An entirely new method of cut-off control for a reciprocating steam engine has been developed and patented, the simplicity of which is shown by the statement that only one part, namely, the cut-off sleeve, has been added to the standard valve operating mechanism of the poppet-valve Universal Unaflow steam engine.

In the cross section Fig. 1, "A" is the upper seat of a standard type expansion-compensating poppet valve used on all Universal Unaflow engines, the valve being in an open position. "B" is the cut-off sleeve shown in its lowest position, the lower edges of the ports in the sleeve being on the same plane with the cylinder seat for the valve. The higher the sleeve is raised, the shorter the cut-off, as the valve lift is constant and the cut-off is entirely controlled by the sleeve.

The cut-off sleeve has a loose sliding fit in the valve chest and on the valve, no attempt being made to have the fit steam-tight. The sleeve is raised or lowered by a small double crank engaging a groove inside the lower end of the sleeve, and this crank is connected to a manual or automatic control.

The sleeve is perfectly balanced against steam pressure and requires very little effort of the automatic control; or, if manual control is employed, the sleeve may be easily moved when the engine is in operation by means of a small hand wheel placed on the outside of the cylinder.

As the sleeve is raised the effective opening of the valve is diminished until the sleeve reaches its extreme upper position, and in this position the lift of the sleeve is equal to the lift of the valve, and no effective port opening is obtained. It will be seen, therefore, that the valve is not perfectly sealed until it has seated. There will be a slight amount of leakage between the period of sleeve cut-off and the seating of the valve. However, this leakage is found to be offset by the gain in economy due to the elimination of the wire-drawing tendency of any standard cut-off gear during the short period immediately preceding the instant of seating. The cut-off, therefore, is somewhat sharper and the fullness of the card greater.

This will be seen on the indicator cards shown (Fig. 2), which are accurate reproductions with the engine running at a speed of 200 r.p.m.

Figure 3 shows the assembly of the valve, cut-off sleeve, and bushing surrounding the operating shaft with attached gear, which is connected to the automatic or manual control. The sleeve in this illustration is in a somewhat raised position for an intermediate cut-off. Figure 4 is a disassembly of the valve, sleeve, operating lever for sleeve, and the lower valve seat.

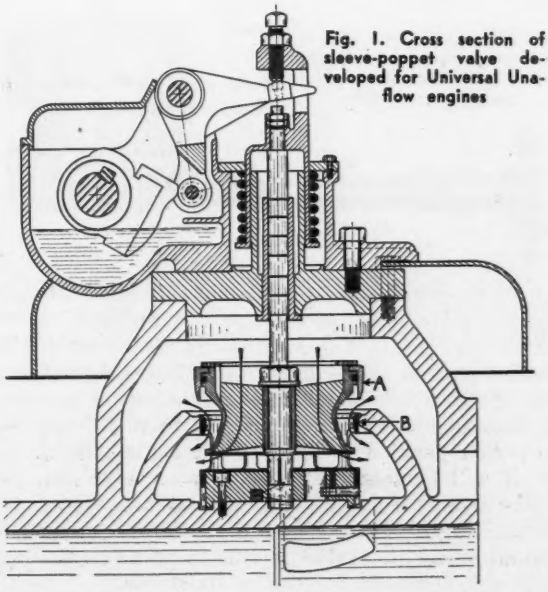


Fig. 1. Cross section of sleeve-poppet valve developed for Universal Unaflow engines

Figure 5 shows the difference in the functioning of the sleeve-poppet valve, so far as cut-off conditions in the cylinder and the resultant gain in economy over the conventional poppet valve having a variable lift are concerned.

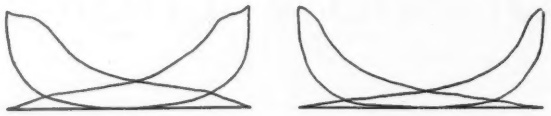


Fig. 2. Indicator cards from engine running at 200 r.p.m.

The indicator cards in the lower tier are exact reproductions of indicator cards obtained on a standard variable-lift gear taken from a 24-in. stroke horizontal engine with approximately 150 lb. steam pressure, noncondensing, and with loads from about one-third to full load.

The diagrams in the middle tier are actual reproductions from valve lift indicator cards taken from the same engine and simultaneously with the indicator cards in the lower tier. The indicator was so mounted that it would record the exact lift of the valve with respect to stroke of the piston. The shaded area, which represents the valve opening, beginning slightly before dead center, rises rapidly to the maximum lift for the particular cut-off being used, and then slopes off as the cam recedes, the ramp on the cam serving the purpose of seating the valve slowly.

It is to be noted that the theoretical steam cut-off as shown by the indicator cards is somewhat less than the mechanical cut-off as shown by the lift diagrams, and that the former occurs at a point of approximately one-third the total lift of the valve in each case. In other words, from this point down there is some wire drawing even with a variable cut-off gear, and the amount of this wire drawing can be measured from the indicator cards.

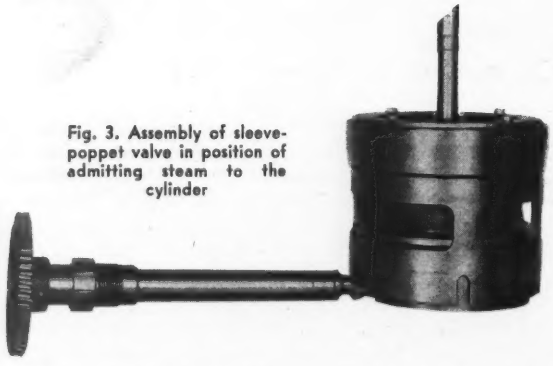


Fig. 3. Assembly of sleeve-poppet valve in position of admitting steam to the cylinder

The upper tier of diagrams shows the full lift of the poppet valve used on the sleeve cut-off design, this lift being constant for all loads and speeds. The shaded portion of the diagrams indicates the net opening of the valve which is varied by means of the sleeve surrounding the valve, this sleeve in turn being held in proper position by hand or automatic control.

It will be seen that this type of valve gear produces a sharper cut-off, since the action is similar to a sliding valve traveling at full stroke and making the cut-off while the valve is still in rapid motion and before it comes to the end of its stroke.

This is in contrast to the seating of a standard poppet valve without sleeve, which must come more slowly to its seat on account of the design of ramp on the cam.

The resultant economy is shown from the tests made on a 19 by 20-in. sleeve-poppet-valve engine having a full load rating of 250 hp. with an average pressure of 135 lb. saturated steam and atmospheric exhaust:

I.hp. load	100	150	200	250
Steam per i.hp.-hr.	18.5	17.7	17.8	18.3

These are remarkably low steam rates for any type of steam engine operating under the conditions named.

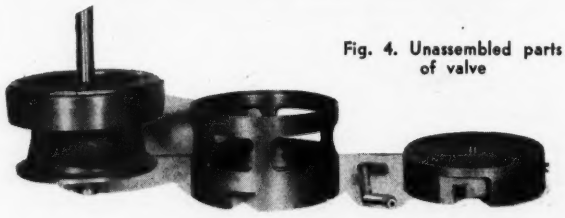


Fig. 4. Unassembled parts of valve

In the heading of this article is shown a Universal Unaflow engine having this sleeve-poppet valve, the speed being controlled by the flow of oil from a high-pressure hot oil pump. The overspeed governor in this installation is driven from a shaft geared to the crank. However, many installations have been made with the governor belt driven directly from the engine shaft.

This governor does not function as a throttling governor, but merely as an overspeed device in case the load is suddenly dropped by the pump or compressor driven by the engine.

The small hand wheel with dial mounted on the cylinder is for controlling the cut-off of both sleeves by hand when desired.

A considerable number of these engines are in operation in the United States and foreign countries, and this control has been used on multi-cylinder vertical as well as on horizontal variable-speed unaflow engines.

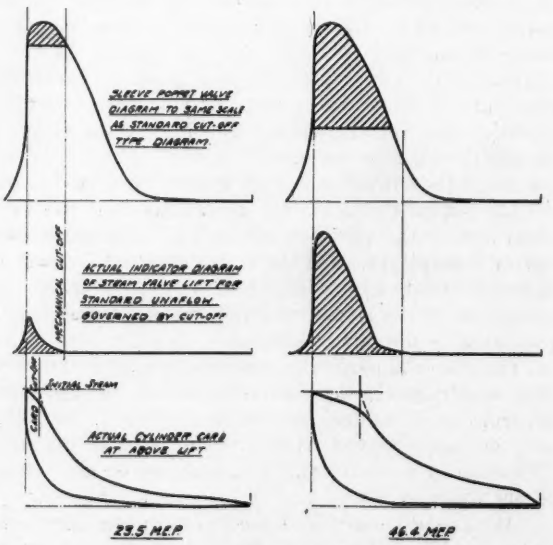

SLEEVE POPPET VALVE DIAGRAM TO SAME SCALE AS STANDARD CUT-OFF TYPE DIAGRAM
ACTUAL INDICATOR DIAGRAM OF STEAM VALVE LIFT FOR STANDARD UNAFLOW GOVERNED BY CUT-OFF
MECHANICAL CUT-OFF
ACTUAL CYLINDER CARD AT ABOVE LIFT
29.5 M.E.P
46.4 M.E.P

Fig. 5. Indicator cards taken to illustrate the functioning of the sleeve-poppet valve

Readers' Conference

Engineering Achievement

JAMES GIBBONS in his interesting article, in the October issue, refers to two previous communications on the subject of success in engineering.

Philosophically he agrees with the conclusions of Mr. Pef and states that the art of being "happy though broke" is well worth cultivating. I quite agree with this statement. Fortunately, however, he goes further and points out the grave dangers of this laissez-faire attitude. I say "fortunately" because many young engineers going into their technical jobs this fall will be greatly influenced by the words of the experienced men appearing in these pages.

My previous article on developing sales ability among engineers is referred to by Mr. Gibbons, and he qualifies his philosophical remarks, quoted above with the conclusion that, since objective rather than metaphysical terms are the main interests of Power Plant Engineering, the suggestion I made for all young engineers to take a turn at selling is a valuable one.

It can be said that the joy of real achievement outshines other human reactions. Nothing is more satisfying to one's inherent ambitions than success in one's chosen field of endeavor, and success in its full meaning comes to us only as we analyze, and can develop within us, our abilities in understanding and co-operating with our fellow men.

I sold brushes from house to house during college vacations, because I knew that engineering education needed to be supplemented quite substantially by training in human nature, just as a clock needs a balance wheel in order to make it run. One particular duster in my kit of brushes—an especially heavy one for cleaning furniture—did not sell at all. Since it represented substantial potential profit if I could overcome people's prejudice against it, I studied my prospects' reactions to it. Finally I discovered that the duster was too heavy to use without causing fatigue.

One day I read in one of the company's sales manuals, the following advice:

"Always overcome objections before they are brought up by the prospect."

So I tried these words of wisdom, just to see what would happen. After demonstrating the duster in detail I gave it to the prospect so she would have to grasp it by the handle. As I did so, I said, "And you notice how very *light* it is, for such a *large* duster!"

It worked! The duster sold like hot-cakes! As far as I know it weighed exactly the same to the last gram as it had before, but I had used the power of suggestion. My subsequent earnings from the sale of the duster increased substantially.

Did I learn from first hand experience one of the important fundamentals of human reasoning? Did I profit later by that valuable and memorable example? In my present humble, though fascinating, business of contacting users of industrial power, that one experience alone has been of inestimable value in whatever success I've been able to achieve in the engineering profession.

Experts on human reasoning, psychological reactions, and the like, have written volumes on how to influence people. There is no substitute, however, in this important phase of success, for learning from first hand information, and by actual experience in dealing with all sorts and types of people, day in and day out. In this training school of applied psychology, there is no better location than in the front line trenches of actual hard hitting, old fashioned selling.

But the purely selfish motive for engineers to "humanize" themselves is merely secondary to the great need that exists today for their leadership. The future of our economic and social life as we have known it rests on the recognition on the part of the engineering profession that the scientist has to date been too steeped in his hyperbolic formulae, too deeply buried in his log-log curve sheets, to take his fair share of the burden of his physical inventions. The purely human side of engineering is calling to every qualified technical man in the land. The degree to which this call is heard and answered in the form of concrete solutions of our social problems, with a view to alleviating the human difficulties that have unwittingly resulted as by-products of scientific achievement will determine the future status of the engineer as an important member of society. If the brains of the engineering profession were concentrated on these problems in the same white heat of human endeavor as is done on the building of bridges and the construction of high efficiency power plants, then the future trends of our economic and social life might receive better guidance, to our ultimate and everlasting benefit.

Waterbury, Conn. L. M. DURYEE.

Oil Burners for Power Boilers

I QUITE agree with most of K. L. Martin's statements, appearing in the November issue, but I think that there are one or two points which deserve further discussion.

The author states that steam atomizing burners will operate with a steam consumption of from 0.6 to 1.3 per cent of the steam generated. This may be true in the case of the particular make which he no doubt has in mind. It may also be true that in the case of large boilers such as those found in public utility plants, the fight over the method of admitting air, rather than the method of atomizing, but in the case of the general run of industrial plants the question of double banking the burners does not so often arise, and I think that the argument is more often concerning the amount of steam which the steam atomizing burner will require in practical operation. Seldom indeed will you hear such low consumptions as those mentioned seriously discussed.

In the case of the mechanical pressure type of burner, the weight of oil and the head against which it will have to be pumped are readily figured, and we have plenty of reliable data on the economy of pumps, so if we make an intelligent estimate of the amount of steam

required to operate the pump for mechanical atomization, we can feel confident that it will not be materially exceeded in practice. Moreover, as Mr. Martin has stated, a steam atomizing burner may require as high as 90 lb. pressure on the oil and an allowance has to be made for this, whereas our estimate for pumping with a mechanical burner will cover both the circulation and atomization of the oil.

In his concluding paragraphs, Mr. Martin says that not only higher pressure but higher temperature of the oil required for mechanical atomization can be balanced against the losses due to steam atomization, but in a previous paragraph he says that high temperature is also better for steam atomization, from which one may reasonably infer that he considers that the slight additional cost is more than paid for by improved combustion efficiency. In any event, the amount of heat in say 50 deg. more temperature, is only about 25 B.t.u. per pound of oil, or less than 75 B.t.u. per boiler horsepower hour, which is a negligible fraction of the heat in one boiler horsepower of steam.

Even if we should find that we require as much as 0.6 per cent of the boiler output for mechanical atomization, we know that only unjustifiable carelessness will cause this figure to be exceeded but it is very easy to waste steam with a steam atomizing burner and in most plants there is really no check on the amount of steam used.

Unfortunately there is not much reliable information available as to the amount of atomizing steam used in the average industrial plant. I do not question Mr. Martin's figures as applied to the particular burners to which he apparently refers, but I think that he will agree that many steam burners can be, and often are, operated in a very wasteful manner, and many of them cannot be operated with less than 2 per cent of the amount of steam generated.

As a matter of fact, the direct acting steam pump which is often used for operating mechanical burners is a decidedly inefficient steam engine and there does not appear to be any inherent reason to believe that a steam atomizing burner cannot be designed which will be at least as efficient as an energy convertor.

Some steam atomizing burners such as the external mixer, do not require a great deal of pressure at the steam outlet to produce the jet, which means that very often a great deal of the mechanical energy which should be available for this purpose is wasted through throttling of pressure reduction at the control valve before the steam even enters the burner. No matter how produced, atomization is a mechanical process, and where steam is used for this purpose we have the same kind of problem as we have in the efficient design of a steam engine. This is a point which appears to have been too often ignored when designing oil burners, although in some cases worth while progress has been made in this direction.

There is no doubt that steam atomizing burners have some decided advantages, especially on widely varying loads, and it would appear that the principle of using the steam at the point where atomization occurs, rather than in an admittedly inefficient steam pump offers theoretical possibilities of considerable saving in power, but as a practical proposition the control must be of such a nature that efficient operation can be maintained under standard operating conditions.

Perhaps nothing would help the cause of the steam atomizer more than the development of a reliable instrument which would indicate the amount of steam actually being used. We often find everything else carefully measured and indicated, but the amount of steam used in the burner is something which everyone guesses at but nobody really knows.

Bloomfield, N. J. JAMES O. G. GIBBONS.

Utilize Your Exhaust Steam

DESPITE the constant preaching about utilizing exhaust steam we continue to see it wasted. Board a train almost anywhere and observe the clouds of exhaust heat going to waste as you travel from city to city. It is "pouring out" of almost every factory you look at. No doubt you have said to yourself or to someone else, "Some capable engineer should take that factory in hand and make them utilize that steam."

It is true that during the summer months there is often a plausible excuse for wasting steam. It cannot be bottled up and kept hot until the winter months. At least, it can't be done economically. You can store ice with comparative ease, but steam is different. So, don't feel badly if you find it necessary to waste some steam during the summer. But during the winter every bit of heat in every ounce of coal should be utilized, if possible.

Some heat, of course, is bound to escape through the chimney. But that is all that should be allowed to get away without first doing something. No matter how efficient your steam engine or turbine, it will be difficult for you to transform more than 20 per cent of your heat energy into mechanical energy. That is about the limit in present steam power plants. It means that you are getting a little more than one-horse power per hour out of each pound of coal, assuming 14,000 B.t.u. as the heat value of the coal. The chances are a hundred to one that you are not doing nearly that well in your plant.

So it is urgent that your exhaust steam be utilized. It contains the major part of the heat of the fuel. Use it for heating the feedwater. Use it for heating the buildings. Use it for heating water, for drying, refrigerating, for processing, and for anything else that may be useful. If you still have some left maybe there is a neighbor across the way who would be glad to buy your surplus exhaust if you will tell him the amount of steam you have to sell. Maybe you could afford to pipe it a considerable distance to someone else who needs low pressure steam and who heats boilers of his own just for this purpose alone. Maybe these things are true. Maybe they aren't. Have you ever looked around?

Maybe, on the other hand, conditions are reversed. Maybe "you" need that surplus exhaust steam that is being wasted by your neighbor. Maybe you could buy it from him at a very low price. Maybe, by so doing, you could dispense with the use of boilers altogether.

I have used the word "maybe" so often because I cannot possibly know every condition. It is hoped, though, that these few thoughts will be the means of saving much of your fuel.

Newark, N. J. W. F. SCHAPHORST.

Moisture Gathering Aspect of Coal Stored Out of Doors

MOISTURE CONTENT of coal is one of those things which, like the weather, about which much is said in many quarters, but very little is done. The necessity, however, for taking the loss resulting from moisture in coal, though real, is a matter of degree, and should be so considered. Moisture content of the coal at the point where it is purchased and from which it is shipped is an important item and should be kept as low as possible. There is no good end served in paying coal prices for excess moisture, paying transportation costs on that same excess moisture, and then taking the additional losses due to the presence of excessive moisture at the receiving end.

Outdoor storage is without doubt the greatest single cost factor arising out of the moisture-in-coal proposition. Yet, in many cases, outdoor storage in considerable magnitude cannot well be avoided. In these days, when strikes or other troubles may tie up coal production for quite a length of time, and make it next thing to impossible to obtain at a reasonable figure, storage of large amounts of coal by large industries must continue as a matter of insurance. There appears the one alternative of contracting for periodical delivery of specific amounts of coal, but one must expect to pay for at least a portion of the risk assumed by the seller. It is, therefore, largely a question of amounts, places and cases, that must be considered according to all the factors involved.

Peoria, Ill. JOHN E. HYLER.

Boiler Patches

REFERRING to the article "Boiler Patches" in November issue of Power Plant Engineering, some essentials of interest were apparently omitted.

If the patch were applied solely to eliminate fire checks, it would seem that it would be better to remove the rivets, "V" out the fire checks and weld them, then ream out the holes and redrive the rivets, rather than apply such a small patch over the fire. If the patch in question was to eliminate some other condition (corrosion and grooving), then it would suffice, provided the new material in the patch was of fire box steel and had the same tensile strength as the other parts of the boiler, or a minimum tensile strength of 55,000 lb. per sq. in.

The question as to whether the working pressure would be affected would be governed by the thickness of the patch, since in many cases very light patches are applied which of necessity would reduce the safe working pressure. If a patch, as described, is of the same thickness as other parts of the boiler, then, of course, it wouldn't be necessary to calculate the working pressure as respects the patch. Generally speaking, if the longitudinal distance between the center to center of rivet holes in a patch does not exceed 24 in., it is not necessary to calculate the working pressure on the basis of the patch, unless some odd design or other factor is encountered, such as the placing of too many rivets in a straight line.

Question number 2 about figuring the working pressure of the patch according to the A.S.M.E. Code would not be relevant, because the A.S.M.E. Boiler Code refers only to new work and has no connection with repair work. If it were requisite that the working pressure for the patch be figured, it would be necessary to refer to the State Boiler Code where the boiler was located.

Concerning the allowable stress on various types of braces, the Code (A.S.M.E.) for diagonal weldless braces allows a stress of 9500 lb. per sq. in., but due to the angularity that these braces make with the shell, the allowable load is usually figured at 8550 lb., in accordance with Code requirements. If the through rods, such as used in a h.r.t. boiler, do not exceed 120 diameters and are over 1½ in. in diameter, a stress of 10,400 lb. is allowed, but if the length between supports exceeds 120 diameters, the stress allowed is reduced to 900 lb.

Buffalo, N. Y. JOHN J. TIMMONS.

He Bought His Discharge

SEVERAL YEARS ago a middle aged engineer of many years experience in power plant engineering, was put in charge of the division shop power plant of a railroad. He labored long and hard to produce results with the obsolete and worn out plant that he had, and succeeded very well.

All during this time he knew that he was getting nowhere. Numerous leaks in furnaces, turbines, pumps, and other equipment was robbing him of the fruits of his labors. These, like all such, were hidden and could only be revealed by mechanical detectives.

One day he faced his superiors with the suggestion, or request, that they allow him to purchase steam engine indicators, flow meters and an Orsat to assist in locating the nigger in the wood pile, or the coal pile.

But the bosses couldn't see it that way. They went to great lengths to explain that they could not afford the extra expenditure and that after all the leaks he mentioned might not be so serious, and if they were, they would show up sooner or later.

Our hero then offered to buy this equipment himself. The bosses went into a huddle over this, and after awhile told him that he had their permission to spend his own money on the equipment. Most of executives are that way. Big-hearted, you know.

The engineer went ahead. Bought the flow meters, steam, air, water. Checked up on all departments. Showed by charts and what-nots just where and how everything was going. His Orsat showed up the furnaces for what they were, and the officials were finally convinced and all this equipment was retained as a part of the business.

The engineer was never repaid the money he had spent for the instruments. He was happy, however, in the knowledge that he had convinced the bosses, and was getting results, and that the movement he had started for efficiency would save the company a great deal of money, and he would be remembered in the long run.

There are lots of engineers like that. We may not have met them but we've heard about them, but we don't hear the sequel to many of them. You, no doubt, know the answer. The engineer of our story, is now looking for a job. The very instruments that he bought and paid for, uncovered his own inefficiency.

Wilkes-Barre, Pa. THOMAS M. STREET.

Sweating Pipes

TIME and again we have had complaints of the cold water pipes sweating, that is, moisture condensing on them and dripping over everything in the basement of one of our older stations when the humidity was high and the ventilation poor, that is, air circulation at a premium. A costly remedy would have been the installation of suitable ventilating ducts with the necessary louvers and a blower. The cost, however, wasn't warranted yet it was desirable to remove this condition which could cause considerable trouble if the dripping water was not wiped from the floor during each watch.

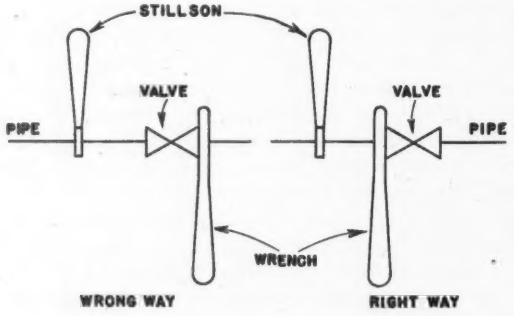
The solution was to paint the copper tubing with a dark, flat paint and then sprinkle ground cork over the surface while the paint was still sticky. It is six months now since the tubes have been treated thusly and to date we haven't had a complaint of sweating.

Tenafly, N. J. KERMIT B. HOFFMAN.

When Installing Valves and Fittings

WHEN INSTALLING piping systems there is a certain technique which if thoughtlessly or carelessly applied can result in considerable annoyance caused by leaky joints and probable expense in replacement of equipment; equipment which had been received from the manufacturer in good condition. Reference is made to the final tightening up of screwed end valves and fittings.

Cases have occurred where screwed end reducing valves have been declared defective or even inoperative, when examination invariably proved that the pipe fitter distorted or twisted the valve body by holding the body by the end farthest from the thread which was being tightened. Held in this manner, distortion of the valve body can occur whether the pipe is being



Improper and proper application of wrenches

screwed into the valve body or if the valve body is being screwed on the pipe. Particularly is this true of brass or bronze gate, globe, or angle stop valves; stop cocks, traps, pressure reducing valves, back pressure and relief valves, safety and blowoff valves; tees, ells and crosses. Even when made of malleable iron or steel, valves and fittings are subject to distortion when screwed up tight in the erroneous manner described.

In the case of fittings the most serious result caused by improper tightening would be a leaky joint; but when applied to an expensive reducing valve, distortion of the valve body causes a misalinement of internal working parts and results in a sticky, jerky, erratic performance, or even complete immovability of the operating mechanism.

When the system is tested and tuned up the engineer in charge forms a bad opinion of the valves "holding up the works" and the manufacturer of course is criticized for poor workmanship or design.

Sketches herewith show the wrong and the right way of installing valves and fittings. Experienced fitters know and apply the right method, but those inexperienced or careless, particularly when hurrying a job, apply the wrong method with the bad results noted above.

Philadelphia, Pa. WILLIAM F. KUNZ.

Then and Now

IT HAS been a great pleasure for me to read the comments of James O. G. Gibbons and J. R. Darnell, page 559 September issue on my article in August issue.

Had the gentlemen doubted the savings I reported by change from 6 per cent CO_2 to the much higher figure of 14 per cent CO_2, I should have been somewhat peeved but to have Mr. Darnell show 51.8 per cent saving is absolutely astounding.

If, in my various writings, I have made errors (and we all slip at times I'm told) those errors have never built up false hopes in the breasts of the young and uninitiated engineers.

On my annual, monthly or weekly inventory no clerk or executive has ever found less material (fuel or other supplies) than I had declared on my sheets.

It has never been my policy to guarantee a 20 per cent saving if new equipment was needed unless I was positive, beyond any doubt in my own mind, that I could fulfill the guarantee.

It's taking good space, I'm afraid, to tell the gentlemen that their formulas, if followed by young aspirants to the chief's desk, would lead to disaster.

Whereas their figures are perfectly o.k. (I admit though my admission wouldn't amount to much among real tech men, being the offspring of a coal scoop) my figures are from the grit and grime of the firing floor and the savings I offered, with the fruits of a hand Orsat that cost me just one iron man each week (and the assurance that I would pay for all glassware broken) were borne out by the coal bills.

In the plant that I operated, not one pound of coal was delivered (at the time I mention) without the money in advance.

Don't you think that we know how much fuel we saved? If I had known how to figure as Mr. Darnell does and had used the same formulas my reputation would have been utterly ruined.

In the last named case, the man who made the tests figured (probably to be safe) as I had and, strange as it may sound, his figures and the results tallied.

Again let me say that I sincerely appreciate the comment but *I dare not use the formula*—though it, without a doubt is theoretically correct. Mine seems to fit me closer.

N. Y. City. C. W. PETERS.

Coal Producers and Users Meet

Fuels Division of A. S. M. E. and Coal Division of A. I. M. E. Held a Cooperative Meeting in Pittsburgh, October 27 to 29

BY BRINGING together the engineers responsible for the production and marketing of coal and those whose duty it is to burn this coal, the American Society of Mechanical Engineers and the American Institute of Mining and Metallurgical Engineers at their meeting in Pittsburgh, October 27 to 29, initiated a coöperative movement that has possibilities more far reaching than could be accomplished by these societies acting separately.

From the viewpoint of the coal user, Gosta Anbro of Colgate-Palmolive-Peet Co. described the principal differences in construction between the chain grate and traveling grate stokers, and pointed out that, contrary to an opinion that was prevalent for many years, this difference has no bearing upon their fields of application. As the traveling grate stoker was developed primarily for burning small-size anthracite, forced draft was a necessity and its application to other types has given industry the only satisfactory stoker for this fuel. The starting changes in furnace design which accompanied the development of stokers was commented upon by Mr. Anbro, the long rear arch construction now used having been provided to reduce the solid carbon lost with the flue gases. It was stated that both these types of stokers will burn almost any solid fuel of suitable size, but low ash content is objectionable and coal should be reasonably uniform in size and free from dust, the latter giving considerable trouble in plants that experience difficulties from tube slagging.

As an example of the benefits to be secured from careful selection of coal for underfeed stokers, a paper presented by J. E. Tobey of Appalachian Coals, Inc., cited the experience of a Middle West industrial power plant burning 700 t. of coal per day, where the boiler capacity was increased from approximately 2100 hp. in 1917 to more than 13,000 hp. in 1924. Errors in design of the original boilers were repeated in each of the three subsequent additions and caused combustion troubles with resulting interruptions to power service and factory shutdowns. Mechanical changes to boiler equipment and an exhaustive coal-selection program resulted in marked improvement in operation. When the latter was adopted, coal might be supplied by any one of 60 different mines which rendered any segregation impossible and compelled burning the fuel as mixtures. In the 3 yr. that elapsed before the program was completed, coals from 130 mines were analyzed and given burning tests under service conditions and the output of 18 mines, none of which were included among the original 60, was found suitable for plant use. Differences between these coals, such as quality, price, degree of satisfaction, mine capacity, and general availability, reduced the number to six and these fuels were given trials for longer periods, with the result that a single coal was finally chosen and has been burnt exclusively for a number of years. The coal-selection program was described in considerable detail in the paper and combustion troubles encountered during the burning tests were mentioned and commented upon.

Prepared Coals

Henry F. Hibley of the Commercial Testing & Engineering Co., in a paper entitled the Economics of Preparing Coal for Steam Generation, discussed the factors pertaining to the problem and cost of mining and preparing steam coal, and the economics of producing steam with such coal. Many tables and curves were presented comparing the quality of raw and prepared coals, such as ash content, heat value, volatile matter, fixed carbon, sulphur content.

As a result of his work in the laboratory of the U. S. Bureau of Mines at Pittsburgh, P. Nicholls reported his findings from tests conducted on coal and coke treated with various chemicals, many of which are marketed as proprietary products under the general name of "fuel savers," the principal sales being in small packages for the use of householders. Common salt, calcium chloride and sodium carbonate were studied for their effect on caking of coals and the rate of gasification. The effects of chemicals on reactivity, ignitibility, tar and soot in gases, smoke and soot deposits, ash and clinkering, sulphur in the fuels, fuel beds of large area, burning on chain grates were all briefly reported. The results, however, were largely negative, the statement being made that for large furnaces an increase in quantity of any of the chemicals that were found to decrease caking or to increase the reactivity would also increase the probability of trouble from clinkering.

Fundamentals in dustproofing coal were discussed in a paper by H. R. Fife of the Mellon Institute and P. W. Edeburn of Butler Consolidated Coal Co. in which a great amount of information was given on coal-dust control, particle size and related surface area, surface film composition and behavior, wax-treating of coal, and methods of applying dustproofing agents.

Coal Segregation

Of particular interest to power plant engineers was the paper by David R. Mitchell of the University of Illinois and the discussion that followed on the subject of Segregation in the Handling of Coal. It was stated that many of the difficult operating problems of the preparation of coal for the market, of sampling coal shipments and in the utilization of coal are caused by segregation in the coal mass. Segregation may be of

two kinds: i.e. "size segregation," in which particles of the same size in a mass of coal containing a range of sizes collect together, and "density segregation," in which particles of the same density of specific gavity in a mass of particles of varying density gather together.

The paper took up a study of the mechanics of segregation which takes place during the handling of coal by the common methods from the mine to the stoker hopper, and pointed out some of the effects of segregation on the quality of the coal and the burning characteristics on various types of stokers. Descriptions were given of several devices developed by engineers to fill bins uniformly and thereby reduce degradation. It was pointed out that if segregation is to be eliminated extreme care must be utilized in the design and layout of all storage and handling equipment from the time coal is broken loose at the face until it is in the particular place at which its energy is changed to some other form.

To the men charged with the responsibility of determining the quality of coal deliveries, the paper entitled Statistical Interpretation of Laboratory Coal Tests and Sampling Methods presented by G. B. Gould of Fuel Engineering Co. revealed the probability of errors that creep into coal test results. He listed six factors that determine the magnitude of the deviations in quality of one lot of a coal from the average quality for a series of shipments as follows: 1. Percentage of ash in coal. 2. Size. 3. Ratio of free impurities to total impurities. 4. Nature of the free impurities. 5. Method of mining, loading and preparation. 6. Shipment from two or more mines as a single product. The author was of the opinion that contracts should be drafted with a clear understanding as to whether the intention is to adjust for differences in average quality, or to set limits, or to combine the two purposes.

Pulverized Coal

B. E. Tate of the National Cash Register Co. presented a paper on the Selection of Coal for Pulverized Firing in which he stated that while sulphur, phosphorus, and hydrogen may, in a consideration of the entire boiler unit with its heat-recovery apparatus, render an otherwise satisfactory coal unsuitable for that particular installation, certain other characteristics are of primary importance in selecting fuel for a powdered-coal-fired furnace. These characteristics are (a) use value, (b) heat content, (c) grindability, (d) volatile content, (e) moisture content, (f) ash-fusion temperature, (g) ash content, (h) size of coal, (i) foreign material, and (j) fly-ash characteristics.

Selection of coal for pulverized firing, in his opinion, is not a job for the purchasing agent alone. Regardless of how well he may be informed upon price and freight costs of coals and upon their characteristics as given by the proximate or ultimate analyses, the purchasing agent cannot be expected to evaluate coals from the viewpoint of use value, because of his lack of intimate knowledge of the characteristics of the apparatus in the boiler plant. Only the informed engineer is qualified to make that evaluation. Coöperation between purchasing agent and engineer is essential if advantage of available coals is to be obtained.

Small Stokers

During the past decade great strides have been made in the development of automatic fuel burning equipment for handling small quantities of coal. In this field, the Stoker Manufacturers' Association has been outstanding in its contributions to the advancement in the art of coal burning and through its president B. M. Guthrie of Fairbanks, Morse & Co. presented a paper on Small Underfeed Single-Retort Stokers.

Although concerned with the mechanical development of small underfeed single-retort stokers having an hourly capacity of 1200 lb. and less, the paper specialized on their development and application for residential heating. A discussion of the various methods of feeding coal was first presented and was followed by a resumé of the classification of stokers on the basis of hourly coal-feeding rates, which was recently made by the United States Department of Commerce in coöperation with the Stoker Manufacturers' Association. Design and mechanical details of these stokers for house heating were commented upon at some length, variation in combustion rates with size of stoker and grade of coal was touched upon, importance of proper furnace volume and height were stressed, and the influence on furnace design of the type of load to be carried and the essentials of good furnace design were mentioned. Several tabulations of data supplemented the paper. Brief sections relating to the use of stokers with anthracite coal and the heat-control devices for both anthracite and bituminous-coal stokers were presented.

From R. A. Sherman of the Battelle Memorial Institute came a resumé of present coal burning practice under the title Status of Our Knowledge of Coal Selection for Steam Generating Equipment. He indicated that the papers presented at this meeting left out only one important type of coal burning equipment, this being the spreader stoker, its omission being due to the fact that it had been treated at the Semi-Annual meeting of the A. S. M. E. in Detroit. Mr. Sherman's paper reviewed the papers on the selection of coal for the five types of burning equipment, summarized the characteristics of coal that are important in all types of combustion and those that are distinctive to certain types, and considered how our knowledge could be improved and along what lines our further search for knowledge on coal and on burning equipment might profitably be directed.

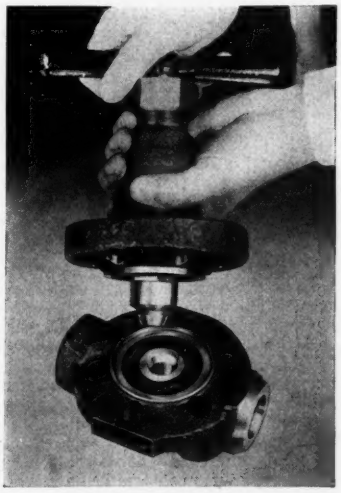
The answer to the coal-selection problem that was given in this paper consisted of two phases, (a) research and (b) education. The burden of research in utilizing bituminous coal has, until recently, rested almost entirely upon large users of coal, manufacturers of burning equipment, universities, and the government. A few large producers have conducted research upon their own coals but no general program on bituminous coal has had the producers' support. Now, however, the industry is supporting research and education on coal utilization. The National Coal Association has had since last year an engineering department at whose head is C. A. Reed with long experience as a user, manufacturer, and producer. Education is the principal work of this department.

New Equipment

Information that you desire about any equipment will be gladly furnished without obligation. WRITE POWER PLANT ENGINEERING.

New Valve

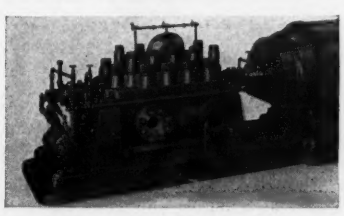
HANCOCK VALVE DIV. of Manning, Maxwell & Moore, Inc., Bridgeport, Conn., announces a new type of steel valve called the Hancock Duravalve developed expressly for high pressure and high temperature service, up to 1500 lb. at 950 deg. F. Duravalves have internal Stellite seats and the accompanying illustration shows how the new design permits the



Stellite seat facing to be easily welded in and serviced even on small size valves. The valves are made in one basic size and then tapped, or bored for welding, for ½, ¾ or 1 in. pipe. The builders state that this simplification will take care of 90 per cent of the small valve requirements on any high pressure power plant job, and will cut repair and maintenance parts by two-thirds.

Doubleton Pump

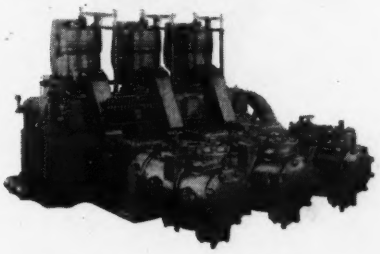
ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., has recently introduced an improved design of multi-stage pump into the high pressure boiler feed pump field. This pump is called the Doubleton type because of the use of double suction impellers, and the double balance of the rotating element. The double suction impellers provide axial balance and the positions of the successive volute passages By contrast, a common nail is under 200



which surround each impeller are made so as to largely equalize unbalanced radial forces on the impellers. These pumps are made with horizontally split casings for pressures 1500 lb. and above. The design and bolting has been so worked out, based on the Company's experience with bolting high pressure, high temperature steam turbine casings, that no difficulty is experienced in maintaining a tight joint and retaining the advantages of the split casing construction.

Gas-Driven Angle Compressor

DESIGNED specifically to give low installation cost, the Super 2-angle compressor unit is announced by Clark Bros. Co., Olean, N. Y. The unit is built with the power cylinders vertical and the compressor cylinder horizontal, making a 90 deg. angle. The engine works on a 2-stroke cycle and ranges in size from 150 to 600 b.hp.

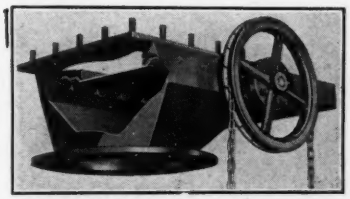


Principal savings in installation result from a reduced foundation cost per horsepower; lower transportation cost, and small floor space requirements which result in lower building cost. Foundation requirements are low, being only 0.07 cu. yd. per b.hp. for the 600-hp. unit. The standard horizontal 250 b.hp. unit requires but 1.60 sq. ft. of floor space per b.hp. and the 300-hp. unit only 0.427 sq. ft.

Power pistons are oil cooled. Scavenging air at from 3 to 3½ lb. is supplied by a separate compressor direct connected to the engine shaft. Gas is admitted to the power cylinder under a pressure of 15 to 20 lb. by means of a fuel injection system used on all Clark 2 cycle engines for a number of years. In this system a small fuel injection poppet valve is operated by a push rod and a governor controls the pressure to the injection valve. This feature is said to render the engine insensitive to variations of B.t.u. content of the gas and capable of operating economically over a wide range of fuel conditions.

Coal Valve

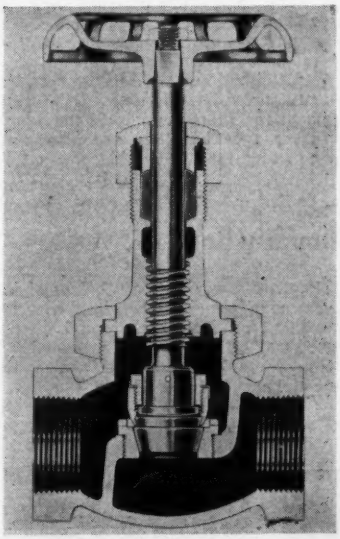
MADE in four types for inclined or horizontal mounting, the Seco Coal Valve can be supplied with either round or square top and bottom flanges, with either stud or bolted top flanges, in sizes ranging from 12 to 18 in. It is made dust-proof and moisture-proof with the U shaped gate designed to keep the moisture away from the rollers, racks and pinions. The gate moves on ball bearing rollers, equipped for pressure greasing and having metal dust seals, mounted in side pockets



away from flow of coal. The gate is driven by a protected double rack and pinion and moved by a chain operated sheave. It was recently introduced by the Stock Engineering Co., Penton Bldg., Cleveland, Ohio.

Jenkins Plug-type Valve Seat

ANNOUNCEMENT is made by Jenkins Bros., 80 White St., New York, of its Fig. 976 Plug-Seat Valve that features a plug and seat ring made of Jenkins JX500, a superior stainless steel having a Brinell hardness in excess of 500. This valve is

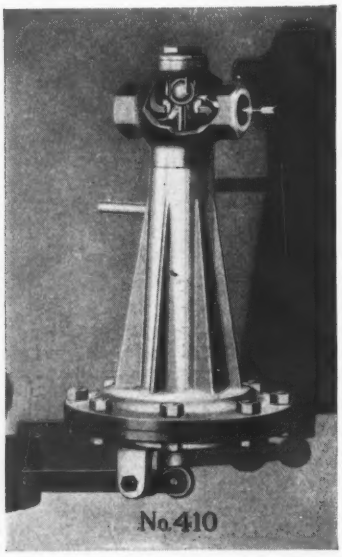


specially recommended for severe service such as continuous throttling for pressure reduction or free blow duty such as soot blowers, injectors, heating coils, or any steam line where close regulation is required.

Boiler scale, pipe chips, welding heads, rust tubercles and iron oxides are all under 500 Brinell hardness, therefore not able to even scratch this new Jenkins valve seat.

Direct Acting Reducing Valves

KLIPFEL MANUFACTURING CO., 2641 W. Harrison St., Chicago, has placed on the market a new line of direct acting reducing valves which incorporate several new features. The one shown in the accompanying illustration is designed for reduced pressures from vacuum to 50 lb. The pressure is easily adjusted by changing

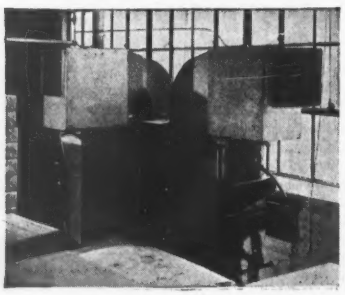


the weight on the lever. Unlike many reducing valves, the outlet pressure tends to rise as the inlet pressure falls, thus helping maintain the full reduced pressure even when the supply pressure drops on heavy demands. The large capacity of these valves with low pressure drop is due to the tapered form of the openings between the ball and the beveled seat, and to unobstructed body passages. The valve shown in the illustration is of the weight and lever type but they are also made in the spring type or liquid column type.

Humidity Box

DEVELOPED over the past 2 yr. and just announced by Humidity Headquarters, The Humidity Box is essentially a high efficiency spray or fog chamber, provided with suitable water filter and nozzle, air filter-eliminator or baffle, and drain fitting.

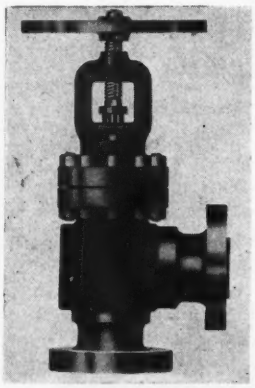
Where less than 30 lb. per sq. in. water pressure is available, an electric vaporizer



may be used to secure atomization. The device may be used with propeller type unit heaters, or in fact in any warm air current, as well as on the warm air outlets of a blower type unit heater as shown in the illustration. It is manufactured by the Air Conditioning Supply Co., 1893 E. 55th St., Cleveland, Ohio.

Forged Steel Stop Valve

THESE VALVES, made from a single block of forged steel in sizes from 2½ to 8 in., and for pressures up to 2,500 lb. per square inch, can be furnished with flanged ends or with ends prepared for any type of welding. They are also made in both angle and offset types and are produced in conformity with A.S.M.E. specifications. The off-set valve, which is of



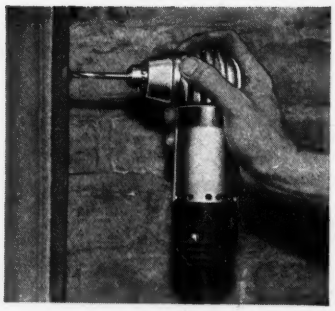
the undirectional type, has a low pressure drop and a special internal bypass is provided for the larger valves when used in high-pressure service. Bodies, flanges, and bonnets are all hammer forged from chrome molybdenum steel, seats are Stellite faced, bolting is of class "C" A.S.T.M. steel and the trim is of stainless steel. Clees Valve & Engineering Co., New York, N. Y.

Tank Car Blower

THIS BLOWER, weighing about 55 lb. and using a ¼ hp. totally enclosed universal motor is provided with a coupling for attachment to the nipple at the bottom of the tank car. It will deliver approximately 600 cu. ft of air per minute which is said to be sufficient to thoroughly ventilate a tank car, and supply fresh air to men working within the car. It is made by Coppus Engineering Corp., Worcester, Mass.

New Ball-Bearing Electric Drill

THE "SHORTY" Ball-Bearing Electric Drill is a new unit presenting an entirely new principle of electric drill construction. The chuck spindle is mounted at right angles to the motor, and reduces the overall working length of the tool to 4½ in. The motor dimensions have also been reduced to a minimum so that the tool fits snugly in the operator's hand, and requires no extra handle.



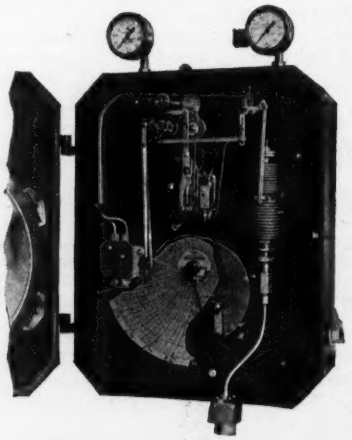
An ingenious ventilating arrangement assures cool motor operation. Deep vents cast in the gear-head provide for free passage of air, even though the tool is grasped by the head. The tapered end of gear-head extends over the chuck, protecting operator's fingers.

The unit is ball-bearing equipped throughout and has a universal motor which operates a.c. or d.c. The brushes are easily accessible for inspection. It is made by the Black & Decker Mfg. Co., Towson, Md.

Absolute-Pressure Instruments

COMPLYING with advanced engineering practice which specifies the absolute-pressure system for low pressure measurement, the Taylor Instrument Cos., Rochester, N. Y., have just announced a new line of instruments for indicating, recording and controlling absolute pressure.

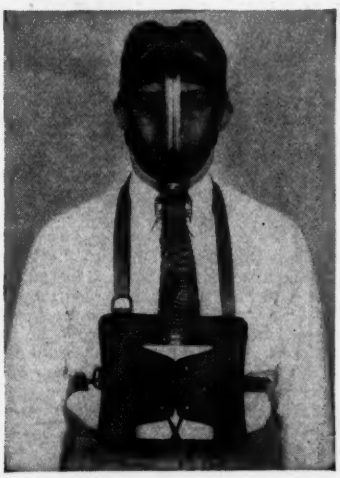
These instruments are applicable to distillation units, evaporators, condensers and in general wherever the corresponding mercury type of gage can be used, with the exception, of course, of gases or vapors corrosive to the bronze bellows used in the instrument. They are particularly applicable to turbine exhaust, or, condenser pressure, and vacuum return lines.



The absolute-pessure element used consists of a flexible phosphor-bronze bellows to the inside of which the pressure medium under measurement is communicated. Connected with this assembly, and opposing its action, is a second identical metal bellow which has been evacuated and sealed, thus comprising an atmospheric-pressure compensator.

Industrial Gas Masks

FULL VISION LENSES, which permit the wearer to see, read, work, walk and observe surroundings in safety, feature the new full vision gas masks manufactured by the Acme Protection Equipment Co., 2682 Koppers Bldg., Pittsburgh, Pa. The lenses are made of scatterproof laminated polished plate glass and afford 50 deg. vertical and 170 deg. lateral vision.



Both corrugated tube and snout types are available. The light weight, all-rubber face piece is fully molded and cured to master face fitting proportions. Head harness connections are strategically located so as to eliminate all forehead pressure points, permitting wearing of hat or helmet without discomfort.

These full vision gas masks are available with a choice of elastic, all-rubber or permanent non-rubber head harnesses and a wide selection of canisters covering organic vapors, acid gases, ammonia and industrial smokes, hydrocyanic acid and all known military gases and smokes.

Stainless Steel Refinery Gage

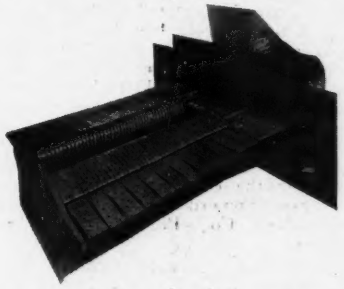
STAINLESS STEEL bourdon tube and a new method of zero adjustment are the features of this gage. For pressures below 100 lb. a drawn steel bourdon tube is used, but for pressures above 100 lb. the gage incorporates a lathe-turned tube as illustrated, which is rough-bored, rebored and reamed to an accuracy of 0.0005 in., with special method of sealing by socket and cone, which according to the manufacturer,

will hold tight up to the melting point of the steel and withstand pressures far beyond the operating pressures of any given gage.

Zero adjustment, known as the Recalibrator, was developed, according to the manufacturer, to correct the distortion of the tube. Correction is made by a readily turning screw until the pointer is at the zero position when pressure is removed, or is correct at any given point on the scale. The gage will then be correct at all points on the dial. Detailed information covering pressure ranges, finish, etc., are available from the manufacturer, Jas. P. Marsh, Corp., Chicago, Illinois.

Canton Low Set Stoker

RAM TYPE underfeed stokers manufactured by Canton Stoker Corp., Canton, O., are now designed for low head room installation and contain a number of other unique features which add to the convenience of operation and the life of the stoker. These units are of all metal construction providing a windbox with sliding cleanout panels. The hopper and driving mechanism extends only 59 in. in front of the boiler, the gearbox being dust proof and equipped with Timken bearings, while the motor is mounted 24 in. off the floor and covered with a protective shield.



These stokers can be furnished with either unit or separate stoker and fan motors. The retort ram is adjustable while the stoker is in operation and the unit is provided with seven feed adjustments and unlimited air adjustments. Extra heavy alloy iron is used in the construction. The extremely low head design has extended the field of application.

Cord-Construction Conveyor Belting

THIS NEW BELTING has plies of longitudinal parallel cords, surrounded and insulated with rubber, and has no transverse or filler threads, so that it is free to bend laterally to the shape of rollers for troughing. This is stated to give great ability to absorb and withstand shock, easy flexing over all pulleys, resistance to penetration of moisture or acids, even into a cut or gouge, and long wear. Any length, width or number of plies can be used but the belt must be spliced endless on the conveyor by a portable vulcanizing equipment, as no fastener has so far been devised which will work satisfactorily on this type of belt. B. F. Goodrich Co., Akron, Ohio, is the maker.

Bin-fed Stoker Drive

DESIGNED for use in boiler rooms where maximum clearance is required in front of the boiler, a bin-fed stoker with a new type driving mechanism has been introduced by the Iron Fireman Manufacturing Co., Cleveland, O. The gear case and fan unit is mounted next to the wall of the fuel bin. Power from the motor is transmitted by means of a shaft to a chain drive at the back of the unit. This chain drive connects the shaft and feed worm. The machine is designed to fire boilers developing up to 250 hp.

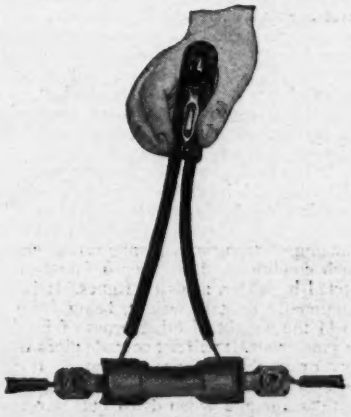
Boiler Feed Pump

WORTHINGTON PUMP & MACH. CORP. of Harrison, N. J., announces the development of a new 10 by 4½ by 10 in. type PG duplex steam pump designed specifically for high-pressure boiler feed and gathering service in the oil fields. The liquid end,

conservatively rated for a working pressure of 1000 lb. per sq. in. is of the side pot type with individual openings provided over each valve for accessibility. The steam end features piston steam valves designed for 350 lb. steam pressure. All pressure joints have been eliminated by casting the steam cylinders and steam chest integral.

Improved Test-O-Lite

FOR A NUMBER of years the Test-O-Lite has been widely used by electricians, mechanics and householders for testing electrical circuits. Today it is a standard tool in almost every shop. Recently, an improvement has been made in this product which includes a pocket clip for holding the



Test-O-Lite firmly in the pocket, preventing its being readily lost. This pocket clip was added at the request of many users. Another improvement is increased sensitivity so that it more easily detects the presence of voltage from 90 to 500

v. a.c. or d.c. by the small neon lamp located in the body of the tester. It is found extremely useful in locating burnt-out fuses, leaks, short or open circuits, or defects in wiring. This devise is made by L. S. Brach Mfg. Corp., 55 Dickerson st., Newark, N. J.

Vibrating Voltage Regulator

ADDITION of a new type of vibrating voltage regulator to its regular line of Carbon Pile Type Regulators, is announced by the Ideal Commutator Dresser Co., 1033 Park Ave., Sycamore, Ill. This regulator is primarily designed for the voltage

control of a.c. generators, which are subject to wide load variations. Its action is very fast, since there are no dash pots, or other damping devices to slow the action of the regulator when load variations occur. All live parts of the Ideal Regulator are enclosed for safety and appearance. It is easily installed and operated.

Fibrous Glass Insulation for Underground Steam Lines

A NEW APPLICATION for fibrous glass manufactured by the Corning Glass Works has been developed by the American District Steam Co., North Tonawanda, N. Y., for the insulation of underground steam lines. Known as ADSCO-Corning Filler Insulation, it is composed of long, flexible fibres of true glass in a soft resilient mass resembling cotton matting but possessing the permanence and chemical characteristics inherent in glass.

It has been proven by tests to possess a high thermal insulation efficiency with a very low conductivity rate of 0.33 at 4 lb. density. It fluffs under vibration instead of packing, settling or disintegrating under such conditions. It is fireproof and unaffected by water, acids or fumes. It is exceptionally light in weight, being from ½ to ¼ the weight of other types of insulating materials. It will not corrode pipes when dry or in the presence of water. It will not compress when thoroughly saturated with water and when dried out, it retains its original form without expansion.

It is packed in strong paper bags at a density which is suitable for maintaining a thermal insulation efficiency for pipe lines operating at a mean temperature of 650 deg. F. or it can be supplied for higher temperatures where required.

P. F. Measuring Equipment for Cables

THE QUALITY of insulation of power cables is reliably indicated by measurements of power factor. High voltage tests may be made during production by means of the phase defect compensation method used in the equipment now offered by Leeds & Northrup Co., Philadelphia, Pa. This affords an accurate means for making such tests, since it does not depend on the deflection of the wattmeter used. Inductance is introduced in the potential circuit of a sensitive dynamometer, so as to reduce its deflection to zero—thus avoiding the necessity for calibration of the instrument. An initial adjustment of the zero of the power factor scale, is made by applying suitable compensation, when using a high-voltage zero-loss air capacitor in place of the cable. The inductor then reads directly in per cent power factor.

New Recording Ink

RECORDING CHART INK, developed by the Permochart Co. is stated to show on tests that it flows freely but does not flood, makes lines that do not spread or feather, dries quickly without smudging but does not cake in the pens. Fifty hours operation has been recorded with one filling of the pen. It is available in 2 and 8 oz. bottles in purple, red or green and is especially adapted for use on the charts made by the company, although giving good results on ordinary paper charts. The Permochart Co., Pittsburgh, Pa., are makers.

Air Conditioning School

SOME SEVENTY distributor-engineers from all sections of the country gathered at East Springfield, Mass., to attend Westinghouse's Application Engineering School for Air Conditioning. Recent investigations and studies by the company lead to the conclusion that, for the next ten years, the air conditioning industry is in a position to absorb between five and seven thousand newly trained men a year. The school, held Oct. 4 to 29, was more than a school of training in the fundamentals of air conditioning, it was actually a laboratory for training in the advanced principles of air conditioning engineering and application. The class room course was supplemented by periodic trips of inspection to the manufacturing, production and test processes involved in building air conditioning equipment.

Special Training in Technical Writing

ANSWERING the need of technical men for a proper mastery of the English language if they are to write for publication clearly and effectively, the Extension Division of the University of Wisconsin, at Madison, is offering a home-study course in Composition of Technical Papers, available to individuals anywhere. This subject is offered as a helpful means of acquiring excellence in writing under guidance, without interruption of the daily occupation.

The course is described as adapted especially to the requirements of active technicians desiring to increase their proficiency in writing business letters, reports, and articles for publication. It presents in a few assignments the essential principles of English composition, introducing the student to an effective professional style, to the planning and arrangement of technical papers, to the important points in paragraphing, punctuation, capitalization, abbreviation, proof-reading, and other phases of efficient writing in a specialized field.

New Officers for United Engineering Trustees

D. ROBERT YARNALL, chief engineer of the Yarnall-Waring Co. of Philadelphia and a national figure in organized engineering, has been elected president of United Engineering Trustees, joint agency of the four Founder societies of civil, mining and metallurgical, mechanical, and electrical engineers. Mr. Yarnall succeeds George L. Knight, vice president of the Brooklyn Edison Co.

Albert Roberts, secretary of the Minerals Separation North America Corp., New York, and Henry A. Lardner of the J. G. White Engineering Corp., New York, were chosen vice presidents. H. R. Woodrow, vice president of the Consolidated Edison Co. of New York, becomes treasurer to succeed Mr. Roberts. J. P. H. Perry, vice president of the Turner Construction Co., New York, was named assistant treasurer. John H. R. Arms, general manager of the Trustees, continues as secretary.

The following trustees were elected by the Founder societies: American Society of Civil Engineers—Mr. Perry; Colonel John P. Hogan, chief engineer of the New York World's Fair of 1939; Otis E. Hovey, New York consulting engineer.

American Institute of Mining and Metallurgical Engineers—Mr. Roberts; W. D. B. Motter, Jr., of the Chile Exploration Co., New York; A. L. J. Queneau of the United States Steel Corp., New York.

American Society of Mechanical Engineers—Mr. Lardner; Mr. Yarnall; Kenneth H. Condit, editor of American Machinist, New York.

American Institute of Electrical Engineers—H. P. Charlesworth, assistant chief engineer of the American Telephone and Telegraph Co.; Mr. Woodrow; Frank M. Farmer, vice president and chief engineer of the Electrical Testing Laboratories, New York.

Mr. Yarnall was born in Delaware County, Penn., on June 28, 1878, and was graduated with a bachelor of science degree from the University of Pennsylvania in 1905. He was associated with the Coatesville Boiler Works from 1902 to 1907 and with Stokes and Smith Co. from 1907 to 1912. He was vice president and general manager of the Nelson Valve Company, Philadelphia, from 1912 to 1918. In 1912 he organized the Yarnall-Waring Co., manufacturers of power plant specialties. He is director and vice president of the Pullenlite Co.

In 1920 Mr. Yarnall was member of the commission in Europe in charge of feeding German children. He served with the American Friends Service Co. and the General Allen Committee in 1924. He is a director and chairman of the public affairs committee of the American Engineering Council and vice chairman of the Engineering Foundation.

Mr. Yarnall was president of the Engineers' Club of Philadelphia in 1929-30. From 1917 to 1920 he was manager of the American Society of Mechanical Engineers. He is also a member of the Franklin Institute and Sigma Xi.

News from the Field

HOMESTEAD VALVE MFG. CO., Coraopolis, Pa., announces the appointment of The Gibson Co., 433 N. Capital Ave., Indianapolis, Ind.; The Keyes Co., 115 W. 5th St., East Liverpool, O.; Minneapolis Iron Stores Co., 512 N. Washington Ave., Minneapolis, Minn.; Dyke Motor Supply of Akron, 372 S. Broadway, Akron, O.; Canton Hardware Co., 122 Third St., N. W., Canton, O.; Dyke Motor Supply Co., 800 Webster Ave., Pittsburgh, Pa.; Cole Brothers, 110 Thirteenth Ave., Nashville, Tenn.; City Auto Parts, 17 Church St., Worcester, Mass.; Automotive Supply Co., Inc., 116 W. Harris St., Appleton, Wisc., as distributors of Hypressure Jenny Steam Vapor Spray Cleaner.

AXEL T. SJOBLOM, electric distribution engineer, Public Utility Eng. & Service Corp., Chicago, Ill., died October 22, at Tucson, Ariz., from a heart attack. Mr. Sjoblom was born in Sweden in 1882, but received his primary education in this country and graduated from University of Wisconsin in 1910, entering the electrical industry immediately after graduation, his first position was with the Commonwealth Edison Co. This was followed by service with: The Isthmian Canal Commission; the Emergency Fleet Corp.; consulting and sales work; and Fairbanks Morse & Co. On November 1, 1926, he was appointed electric distribution engineer of Byllesby Eng. and Mgt. Corp., later changed to Public Utility Eng. & Service Corp.

THE TERRY STEAM TURBINE CO., Hartford, Conn., announces the appointment of the following new representatives who will handle the sale of Terry turbines, reduction gears and turbo-generator units in the territories indicated. C. F. Cate, P. O. Box 2037, El Paso, Tex.; The Darby Corp., Kansas City, Kan.; Ray F. Riddle, 533 Mayo Bldg., Tulsa, Okla.

FIVE NEW distributors for Republic tubular products have been announced by N. J. Clarke, Vice President in Charge of Sales of Republic Steel Corp., Cleveland, Ohio. These include: Bomar Gross, Inc., Jamaica, N. Y.; Drake Supply Co., Los Angeles, Calif.; Iowa Machinery & Supply Co., Des Moines, Iowa; Wilkins Pipe & Supply Co., Peoria, Ill., and Woodmanse Mfg. Co., Freeport, Ill.

EIGHTEENTH Annual Assembly of the American Engineering Council and the Eighth Annual Conference of Secretaries of Engineering Associations, Clubs, Councils, Institutes and Societies in the United States are scheduled for January 13, 14 and 15, 1938, at the Hotel Mayflower in Washington, D. C. A number of problems of common concern to the engineering and allied technical professions are being considered by the committees, and the programs, which include the All Engineers' Dinner, are expected to hold unusual interest for all branches of engineering.

DAVID MAITLAND HARVEY has been appointed by E. F. Houghton & Co. as superintendent of the oil department of its Philadelphia plant, and will be in charge of production of oils for lubrication, metal working, textile and fiber industries. He has had 20 yr. experience in oil production with such companies as Standard Oil, Jacques Wolf and for the last 6 yr. at the Houghton plant in Manchester, England.

DR. PAUL DYER MERICA, director of research of the International Nickel Co. and vice president of the International Nickel Co. of Canada, has been awarded the 1938 John Fritz Gold Medal for "important contributions to the development of alloys for industrial uses". The award is made annually for notable scientific or industrial achievement by a board composed of representatives of the four national engineering societies of civil, mining and metallurgical, mechanical, and electrical engineers.

F. GLADDEN SEARLE of Bronxville, N. Y., has been elected a member of the Board of Directors of Worthington Pump and Machinery Corp. Mr. Searle is also Vice President in Charge of Sales and Advertising of the Continental Can Co., and a Director of the Vincennes Packing Corp. of Vincennes, Ind.

L. J. WING MFG. CO. is making additions to its plant at Newark, N. J., which give considerably increased production capacity. The extensions are being made to the main factory building. The company reports an unprecedented increase in business in 1937.

J. B. TROTMAN, Manager of the Turbine Pump Division of the Roots-Connersville Blower Corp., Connersville, Ind., announces the appointment of exclusive distributors for turbine pumps. Buffalo Mill Supply Co., Inc., 210 Main St., Buffalo, N. Y., will cover the counties which are adjacent to that city and F. W. Allen & Son, 2658 W. 26th St., Erie, Pa., will cover the counties in Pennsylvania and Ohio adjacent to the city of Erie.

SCHRAMM, INC., West Chester, Penna., has completed a new 25,000 sq. ft. factory addition, to mark their thirty-seventh anniversary. The new addition is located directly next to their present three story structure, where the company has been doing business for twenty years.

MORRIS MACHINE WORKS of Baldwinsville, New York, announces the appointment of the Lang Co. as representative in Salt Lake City, with offices at 267 West First South Street to handle sales of Morris centrifugal pumps and hydraulic dredges in that locality.

JOEL D. WOLFSOHN, executive secretary of the National Power Policy committee, has been also appointed assistant to the commissioner of General Land Office.

AMERICAN ROLLING MILL CO., Middletown, Ohio, has recently completed new research laboratories, costing $280,000, erected by The Austin Co. The laboratories are one story, with saw tooth roofs, steel walls and concrete foundation, all welded construction. Insulation and soundproofing are by cork sheets. Wall covering is of two thicknesses of light steel with mineral insulation between, the exterior covered with porcelain enamel, and interior with walnut-finish furniture steel. Twelve laboratories and necessary office space are provided, the entire plant being air conditioned.

PROFESSOR S. C. HOLLISTER, who has been acting dean since the death of Dean Herman Diederichs last summer, has been made Dean of Engineering at Cornell University. He was formerly Associate Dean of the College and, at the same time, was director of the school of civil engineering. Coming to Cornell on July 1, 1934 from Purdue University, where he was professor of structural engineering, Dean Hollister has behind him a record of achievement as teacher and practicing engineer. He was educated at Washington State College and the University of Wisconsin. After practical work in Portland, Oregon, he became instructor in mechanics at the University of Illinois until 1917. He was then appointed research engineer of the Corrugated Bar Company of Buffalo. Following his war service, he engaged in private practice in Philadelphia as a consulting engineer until 1930.

LINCOLN ELECTRIC CO. of Cleveland, Ohio, has opened a sales office in Phoenix, Ariz., in charge of R. J. Reardon. Mr. Reardon, who spent 2 yr. at Mass. Inst. of Technology, then 2 yr. in the Army Air Service, was in charge of Steel Tank & Mfg. Co. of Detroit for 2 yr.; then after 2 yr. as welding engineer and sales manager for C. H. Patterson Co. of Hamtramick, he became welding supervisor for Gilbert & Parker Mfg. Co. of Springfield, Mass. For the 6 yr. last past he has been welding engineer and supervisor for American Metal Products Co. of Detroit. His extended experience should be of value to users of arc welding in the Phoenix territory.

ELECTRIC HOSE & RUBBER CO. has opened a new eastern sales office at Room 919, Rockefeller Plaza, New York City, to serve as headquarters for A. B. Dougall, sales manager, and D. C. Smalley, manager of metropolitan sales. General executive and administrative offices will remain at the Wilmington, Del., plant.

THIRD-QUARTER installations by the members of the Air Conditioning Manufacturers' Association topped the same period of 1936 by 16.5 per cent, installed cost of equipment sold by them totalling $13,239,425, as announced by William B. Henderson, executive vice-president. Association members' total business for the 9 mo. of 1937 was installed cost of $74,036,822, an increase of 90 per cent over the same period for 1936, also 48.24 per cent greater than the total reported for all 1936.

WESTINGHOUSE ELECTRIC & MFG. CO. has declared a fourth dividend for the year of $1 a share on common and preferred stock, making the total for 1937 $4 a share. A. W. Robertson, Chairman of the Board, reports a fair level of incoming orders, with substantial backlog of orders on the books, although not evenly distributed among departments. There is some reduction in inquiries and a few cases of temporarily postponed purchases. For 9 mo. of 1937, orders booked were $191,200,758, an increase of 43 per cent over the like period for 1936, and 48 per cent over the 12 mo. ending Sept. 30. Net income for the 9 mo. period showed increase of 50 per cent.

Forming Concrete at Grand Coulee

THIS MASSIVE and ingenious machine shapes and finishes the lowest section in the "bucket" at the foot of the Grand Coulee dam. This enormous trough, 30 ft. deep, 90 ft. wide, and 1650 ft. long, is formed at the bottom of the downstream face of the dam, and will be submerged under 20 to 50 feet of water. Into it will fall all water passing over the spillway, twice as high as Niagara; and in it will be dissipated the millions of horsepower released by the fall in seasons of high water. Without this artificial plunge-pool, the stream would form its own, with destructive effects upon the channel below the dam. Photo. Bureau of Reclamation.

Steam for the Super Chief?

RECENTLY rumors have been current that six new steam locomotives being built for the Santa Fe Railroad would replace the Diesel locomotives which now pull Super Chief trains between Chicago and California. Officials of the Santa Fe system, however, say that these new steam locomotives will be assigned to handle the heavy passenger train service between Chicago and La Junta, Colo. There will be no change in the assignment of locomotives to the Super Chief and this train will continue to be powered with Diesel locomotives.

Diesel locomotives have made an enviable record in railroad service and seven additional main line units have been ordered by one company from the Electromotive Corp. Other recent orders received by the same corporation include four main line locomotives for the Baltimore & Ohio, similar to the two delivered last summer for the Capitol Limited, and two 5400-hp. locomotives for the Union Pacific, which will be the longest and most powerful Diesel locomotives yet built. These orders from widely separated parts of the country form convincing evidence that the Diesel locomotive is rendering satisfactory service and is steadily growing in popularity.

A.S.H.V.E. Annual Meeting

DURING the week of January 24, 1938, the 44th Annual Meeting of the American Society of Heating and Ventilating Engineers will be held at the Hotel Biltmore, New York City, and the 5th International Heating and Ventilating Exposition will be housed in Grand Central Palace. Simultaneously the annual meeting of the American Society of Refrigerating Engineers and the mid-winter meeting of the National Warm Air Heating and Air Conditioning Association will be held in the Hotel Roosevelt.

At the Society's technical sessions, papers of widespread interest to Society members will provide the opportunity for technical discussion.

Joint sessions with the A.S.R.E. and the National Warm Air Heating and Air Conditioning Association will be held during the week and the three organizations will participate jointly in some of the entertainment functions.

Among the papers of interest to power plant engineers are: Application of District Heating to Steam Jet Refrigeration, by A. R. Mumford and A. A. Markson; Air Distribution from Side Wall Outlet, by D. W. Nelson and D. J. Stewart; Studies on Bacterial Control in Air Conditioning, by T. S. Carswell, J. D. Fleming and H. K. Nason; Control of Air Conditioning in Large, Medium and Small Buildings, by W. E. Zieber and S. F. Nichol; Cooling Tower Equipment and its Relation to Water Conservation, by S. I. Rottmayer; Comparative Analysis of Office Building Air Conditioning Systems, by J. R. Hertzler; Heating Effects of Artificial Lighting on Air Conditioning, by Walter Sturrock; Heat Transfer through Single and Double Glazed Steel Sash, by M. L. Carr, R. A. Miller, A. C. Byers and Leighton Orr; and Condensation of Moisture in Insulated Walls, by F. B. Rowley, A. B. Algren and C. E. Lund.

Some 273 companies will be represented by displays at the Heating & Ventilating Exposition, otherwise known as the Air Conditioning Exposition, which will occupy three entire floors at Grand Central Palace in New York City during the week of January 24 to 28, 1938.

Furnaces, boilers, burners, and heating surfaces will constitute an important section of the Exposition. Related to displays in this field will be those pertaining to radiation and hot water heating. On display will be new, compact, automatic air-conditioners which also supply homes with clean hot water continuously at low cost. The hot water arrangement utilizes the same burner and furnace that air-conditions the home. For heating and air-conditioning large buildings heavy duty automatic oil burners will be featured in terms of new devices to maintain uniform temperatures at varying loads and climatic conditions.

The Exposition is being held under the auspices of the American Society of Heating and Ventilating Engineers, and will be under the personal direction of Charles F. Roth, President of the International Exposition Co., who has directed all of the previous expositions since the first one was held in Philadelphia, in 1930.

A. S. M. E. Annual Meeting

SEVERAL SESSIONS of the Annual Meeting of the American Society of Mechanical Engineers, which will be held at the Society's headquarters in New York City, December 6 to 9, will deal with topics of especial interest to engineers in power plants. One of these sessions will be devoted to critical-pressure steam boilers at which a report of progress of an investigation of the oxidation of metals by high-temperature steam will be given, also methods of protecting steel from intercrystalline cracking in aqueous solutions, the decomposition of sodium sulphite solutions at elevated temperatures and some results from the research on flow nozzles.

High-temperature joints as used in present day industrial practice will be discussed at another session where five papers are scheduled for presentation. At a power session the chlorination of condensing water will be discussed, also three-dimensional pipe bends. A session of four papers will be devoted to the subject of heat transfer in various types of industrial equipment.

New high-pressure, high-temperature power stations will be covered in discussions on the solution of unusual construction problems, capacity and efficiency performance data, troubles with equipment and starting-up procedure.

Water hammer will be considered in three full sessions, one devoted to the general theory of water hammer another to hydroelectric plants and the third to water-works systems. Two sessions will also be given over to papers and discussions of fuels, burning equipment and coal treatment. A session on oil and gas power will give consideration to Diesel-electric switching locomotives and the effetcs of speed and load changes on

mechanical friction losses of reciprocating engines.

Many other technical sessions are planned as well as lectures, social events and inspection trips.

CONSUMERS COUNSEL of the National Bituminous Coal Commission is planning a hearing of consumers to be held in the near future as to the fairness of prices soon to be set by the Coal Commission for bituminous coal. The desire is to learn of any discrimination that may arise from those prices and to learn what consumers think. Consumers will be welcome and the Counsel will arrange for their appearance so as to minimize loss of their time. Those desiring to be heard should notify Consumers' Counsel, Box 483, Washington, D. C., so that notices may be sent them as soon as the date for the hearing is determined.

Controversy on Construction Permits

TWENTY-FIVE REPRESENTATIVES of Wisconsin private electrical utilities vigorously opposed, at a commission hearing held at Madison Nov. 16, a proposed order of the state public service commission, which would require the commission's approval on all electrical construction jobs costing more than $10,000. Favoring the order were John A. Becker, state REA administrator, and other REA officials.

On the ground that utility construction would be badly hampered, if the order were allowed to stand, Vice-President C. E. Kohlhepp, Milwaukee, of the Wisconsin Public Service Corporation, representing the private utilities, urged that the utilities, REA officials, and the commission join in a conference to draft a new order which would be acceptable to all. Mr. Kohlhepp suggested that the private utilities would not oppose the order, if amended to permit construction of jobs up to ten per cent of the total investment of the company without commission approval.

This order was proposed several months ago by the commission as a method of settling disputes over territory between REA districts and private electric utilities.

ANNOUNCEMENT is made by Link-Belt Company of the following changes in the personnel of its management and sales organization. Harold L. Hoefman is now manager of the Link-Belt plant, warehouse and sales office at Atlanta, Ga., to succeed Mr. I. H. Barbee, who died on November 4. George A. Paige has been appointed manager of the Link-Belt warehouse and sales office in Detroit. Laurance O. Millard is the district sales manager at Pittsburgh and Paul V. Wheeler the district sales manager at Cleveland.

THE FEDERAL TRADE COMMISSION, in a finding and order made public by Acting Chairman Clyde L. Seavey today, approves and allows as the actual legitimate cost of the large power project of the Lexington Water Power Co. on the Saluda River, near Columbia, South Carolina, as of June 30, 1932, the sum of $20,123,970.59. Of the $21,648,232.43, representing the licensee's claim of the cost of the project, a total of $1,524,261.84 is disallowed. The project is situated on the Saluda River, about 10 mi. above Columbia, South Carolina, affecting lands in Lexington, Richmond, Newberry and Saluda counties. The earthen dam contains about eleven million cubic yards of earth-fill having a maximum height of 208 ft. and a length of 7800 ft. The reservoir is about 41 mi. long and has a useful storage capacity of 1,607,000 acre-feet with a drawdown of 60 ft. The power house is in four units with an installed capacity of 180,000 hp.

STOCK ENGINEERING Co., Cleveland, O., has announced the appointment of Stanley Sales Co., 1440 Broadway, New York City, as sales representative in that territory.

OPENING of a new branch office and warehouse, November 1, at 376 Spring Street, Atlanta, Ga., has been announced by Jenkins Bros. An important function of Branch Manager C. B. Yardley and his staff and stock of repair parts and valves will be to cooperate with Jenkins' distributors in the South, thus enabling distributors to render better service than ever before.

WORTHINGTON-GAMON METER Co. of Harrison, New Jersey, announces the appointment of W. C. Flanders to the position of Sales Manager. He will succeed G. H. Gleeson, formerly Vice President in Charge of Sales, recently resigned. Mr. Flanders started with the company 15 yr. ago as a salesman in New Jersey, and for the past 2 yr. has been a general representative in the northeastern section of the United States.

KELLOGG PRODUCTS Co. of New York City announces the appointment of W. N. Wilkinson, formerly sales manager of Union Sulphur Co. and president of the Supply and Equipment Section of American Pulp and Paper Association, as general sales manager of the Kellogg Products Co.

LINK-BELT Co. sadly announces the death of I. H. Barbee, manager of its Atlanta plant, on November 4, in a Philadelphia hospital, which he entered about six weeks ago while on vacation.

Mr. Barbee, a mechanical engineering graduate of Purdue University, class of 1908, was a native of Tennessee, where he received his early education. He had a wide engineering experience and served Link-Belt Co. at its Chicago, Philadelphia and Atlanta plants a total of about 25 yrs.

LINCOLN ELECTRIC Co., Cleveland, Ohio, announces the appointment of Robert H. Schuster to the sales staff of the Pittsburgh office, 926 Manchester Blvd., N.S., Pittsburgh, Pa. Mr. Schuster attended Washington and Jefferson College and for the past 5 yr. has been employed in sales work in the Pittsburgh district with the Ault & Wilborg Division of Inter-Chemical Corp. He will be working under the direction of W. R. Persons, recently appointed district manager of the Pittsburgh office.

CHANGES IN ORGANIZATION of Caterpillar Tractor Co. are announced by President B. C. Heacock as follows: A. T. Brown becomes executive vice-president in charge of accounting, traffic and parts, in place of C. Parker Holt, who goes to the San Leandro, Calif., office to direct activities in that district and coordinate departmental work in Peoria headquarters offices. L. B. Neumiller, director of industrial relations, becomes vice-president to administer parts, service and traffic departments. D. G. Sherwin, formerly treasurer, becomes vice-president in charge of advertising, sales and finance. D. A. Robinson, assistant treasurer, is promoted to treasurer.

TRADE MARKS as distinguished from generic terms are protected by law from infringement or use except by the owners of the trade marks. Acheson Colloids Corp., Port Huron, Mich., calls attention to the fact that the word "dag", as well as its various combinations such as Oildag, Aquadag and the like are such trade marks and are its property.

NORTHERN EQUIPMENT Co., Erie, Pa., announces the appointment of Charles A. Randorf, 220 Delaware Ave., Buffalo, N. Y. as the Rochester representative for the Copes System of boiler feed control and allied equipment. This position was formerly held by Alden L. Covill, who is retiring from business.

WISCONSIN POWER AND LIGHT Co., Madison, Wis., announces the appointment of Paul DeLeon, Evansville, Wis., as commercial and new business manager, to succeed Howard W. Cooper, who became executive vice president of the Central Power and Light Co., at Corpus Christi, Texas.

EDWARD F. BARRETT, vice president and director of the Long Island Lighting Co., New York, was elected president recently to succeed Ellis L. Phillips, the latter becoming chairman of the board.

PACIFIC GAS & ELECTRIC Co., San Francisco, Calif., plans to build a $5,000,000 steam electric generating plant near Avon, Contra Costa County, to supply the Avon refinery of Tidewater Associated Oil Co. with electric power and steam needed in refining processes. Power requirements above refinery needs will supplement the P. G. & E. system-wide generating capacity. The plant will consist of a 35,000-kw. turbo-generator to supply an estimated refinery demand of 8,000 kw. The refinery will also be furnished with 720,000,000 lb. of steam annually from three boilers which will generate steam at 1500 lb. pressure and at a temperature of 950 deg.

DELAWARE POWER & LIGHT Co., Wilmington, Del., plans to enlarge the Christiana sub-station at a cost of $300,000. Three large transformers, together with the necessary oil circuit-breakers, disconnecting switches, control equipment, auxiliary equipment and additions to the existing steel structure will be needed.

THE NORTHERN PAPER MILLS plans the construction of an $800,000 steam generating plant at Green Bay, Wis., to take care of its power needs.

ST. MAURICE POWER CORP., Toronto, Ont., and the Brown Corp., a subsidiary of the Brown Co., Berlin, N. H., plan a new $15,000,000 power project with a daily capacity of 162,000 hp. on the upper St. Maurice River near LaTuque. Six vertical hydro-electric units, each with a capacity of 40,500 hp. under a 104-ft. head, will be installed.

THE ONTARIO Hydro-Electric Power Commission, Toronto, Ont., plans to let contracts or make arrangements for direct construction of generating machinery with a capacity of 26,000 hp. at High Falls on the Madawaska River, to be put into operation by the summer of 1939. Cost of the project will be near $1,000,000.

UZAL H. MCCARTER, son of President Thomas N. McCarter, of Public Service Corp., Newark, N. J., joined the advertising department of the corporation Nov. 8. His older brother was recently named assistant vice president in charge of the southern division.

LEROY RICHARDSON, for 8 yr. superintendent of the municipal power and light plant at Murray, Utah, resigned Nov. 1.

CHARLES L. HAROLD, Brooklyn sales agent for the Brooklyn Edison Co. for 12 yrs., has been appointed manager of the special business bureau of the Consolidated Edison Co. He is chairman of the traffic and transit committee of the Downtown Brooklyn Association, and vice president of the Electrical Association of New York.

For the Engineer's Library

Any Catalogs that you wish will be gladly sent. Write Power Plant Engineering.

Boilers, Accessories, Coal and Ash Handling Equipment, Draft and Refractories

Automatic Boiler Service Units are presented in Bulletin 260-B14B. Three types of equipment are described: condensate return for gravity systems, combination boiler make-up and condensate return, and direct feed boiler supply. Units are furnished complete with motors and controls and are offered in sizes ranging up to 150 lb. boiler pressure. Useful engineering data and simplified tables are given, so arranged as to make desired information readily accessible. The Turbine Pump Division of the Roots-Connersville Blower Corp., Connersville, Ind.

How Much Heat—In this booklet is given material presented at a recent hearing of the Consumers' Counsel of the National Bituminous Coal Commission, suggested specific recommendations for classifying coals by grade and rank and for making the information available to purchasers of coal. The plea is for a standard language to describe coal so as to simplify and clarify specifications and enable the consumer to get what he needs and desires. Copies may be obtained by writing Consumers' Counsel, Box 483, Washington, D. C.

Hardinge Operating Data are contained in Bulletin No. 41. The figures were obtained from average operations—not from ideal or special tests. These records are results any man might reasonably expect to secure in every day operations.

It presents the wide range of operations, and the data covers entirely distinct types of equipment used for grinding, classifying, thickening, weighing, feeding and drying. This bulletin is issued by the Hardinge Co. Inc., York, Pa.

Magnesia and Asbestos Products are discussed in a new catalog issued by the manufacturer. The many products of the company are divided into ten general classes and the catalog touches the high spots of the companies line for quick and ready reference. It may be had upon request to Keasbey & Mattison Co., Ambler, Pa.

Micabond—A new 20-page booklet describes a bonded mica insulating material. This material, built up in the form of large sheets or plates from mica splittings is made in many grades for specific uses. Grades of plate stock are made in which permanent rigidity is a feature. Some may be formed when heated. Other knids are pliable under all normal temperature conditions. The booklet gives full information regarding its manufacture, together with comprehensive data on the various types and sizes available. Continental-Diamond Fibre Co., Newark, Del.

Acid-Proof Cement—Line of Acid-proof cements to meet requirements of Chemical and metallurgical industries, public works and utilities; for bonding brickwork of chimneys, acid towers, cooling towers and wall tile in battery rooms, are available in three types: for structures handling hot or cold acid gases, fumes and vapors; hot or cold solutions of acids; repairing masonry where speedy setting is necessary. An 8-page bulletin describing these can be obtained from Quigley Co. Inc., 56 W. 45th St., New York City.

Sheet, Block and Pipe Insulations—New 32-page catalog on Johns-Manville Insulation, which contains specific information on all the classes of insulations which the company has developed for service on heated and refrigerated equipment in industry. A section deals with JM-20 Insulating Brick, a new product placed on the market this year, designed for use as an insulating-refractory and as a back-up insulation behind fire brick lining, with physical properties necessary for service against temperatures as high as 2000 deg. F. Ten pages are devoted to specific recommendations for the insulation of many types of industrial equipment. Copies of this book, Form IN-55-A, are available upon request to Johns-Manville, 22 E. 40th St., New York City.

Insulbrix—A folder giving data on properties of these insulating brick for temperatures to 2600, 2850 and 3000 deg. F. with reduction of heat loss for various furnace temperatures. Quigley Co., 56 W. 45th St., New York, N. Y.

Adsco-Corning Filler Insulation is illustrated and described in Bulletin No. 35-67 which is available by addressing The American District Steam Co., North Tonawanda, N. Y.

Boiler Water Analysis is the subject of a Booklet No. 5102 giving all the latest standard methods of making boiler water determinations. It will be of interest to anyone making boiler water tests and may be had from the Allis-Chalmers Mfg. Co., Milwaukee, Wis.

Electrical Generation and Transmission, Controls, Meters and Instruments

Reeves Motodrive—A 4-page bulletin which gives the reader a good conception of the construction and operation of this product which is manufactured by the Reeves Pulley Co., Columbus, Ind.

Fast's Self Aligning Coupling is the subject of a 40-page catalog which gives a complete discussion of Fast's principle and design. It also includes standard rating tables for all styles of couplings. Bartlett Hayward Division of Koppers Co., Baltimore, Md.

Three suggested specifications have recently been approved by the Transmission and Distribution Committee of the E. E. I. TD-1 covers bolts and nuts used in overhead line construction, TD-51 covers low and medium voltage pin type insulators; TD-71 covers insulator and pin thread and gauges. Copies can be obtained at the headquarters of the Edison Electric Institute, 420 Lexington Ave., New York, N. Y.

Belt Conveyors and Bucket Elevators—In convenient plastic-bound form, which lies flat on the desk, Catalog No. 47 describes and illustrates the complete line of conveyors, elevators, loaders, trippers, parts and equipment. Typical arrangements of conveyors are shown, with 16 p. of data and diagrams on belt conveyor design, covering speeds, capacities, tensions, shafting, drive, power required, feeding and discharging arrangements. Sizes, dimensions and prices of parts are given in complete lists. Numerous illustrations show applications for practically all materials and services. The section on conveyors covers a total of 108 pages.

Bucket Elevators for vertical or inclined arrangement are given like complete treatment of capacities, dimensions and prices with applications illustrated. The entire book of 124 pages has been prepared to give concise information in a form most convenient for engineer's use. Copies will be supplied to those who request on business letterheads. Stephens-Adamson Mfg. Co., Aurora, Ill.

Megger Testers—Three new bulletins describing various types of "Meggers" have been issued recently by James Biddle Co. Bulletin No. 1535 is on improved ohm scales for "meg" and "super-meg" insulation testers. These scales are second and supplementary scales drawn on the same dial as the megohm scale. They can be added to old "meg" and "super-meg" testers or they are supplied on new instruments. Bulletin No. 1540 describes direct reading ohmmeters, while Bulletin 1545 gives data on the constructional features and use of the "midget megger tester," a small, handy inexpensive instrument for general electrical insulation testing. A fourth Bulletin, No. 1530, is devoted to a description of a new line of lamps—"Paintolite Lamps," designed for use in conjunction with electrical and optical instruments. These lamps provide point sources of illumination of exceedingly brilliant and remarkably white characteristics. James G. Biddle Co., 1211-13 Arch St., Philadelphia, Pa.

Optical Pyrometer—Discussion of the problems of measuring temperatures, of how they have been met and solved by the Pyro Micro-Optical Pyrometer, and description and illustration of the apparatus is given in catalog No. 90 just issued by The Pyrometer Instrument Co., 103 Lafayette St., New York City.

Automatic Control for the Steel Industry—A new 16-page booklet covering the application of Askania control of pressure and temperature in various steel plant applications. Engineers will find in condensed form considerable information of a practical nature dealing with the calculation of orifice sizes for air and gas. Askania Regulator Co., 1603 S. Michigan Ave., Chicago, Ill.

Diesels and Gas Engines

American Flexible Hose—the subject of Bulletin EH-7 which discusses the use of product on the Diesel engine exhaust. It was designed for dependibility, ruggedness and flexibility. The manufacturer is the American Brass Co. Waterbury, Conn.

Pyrometers for Diesel Engines—A 12-page book, reprint from the 1938 edition of Diesel Hand Book by Rosbloom, relating the Bristol Pyrometers. This book permits valuable information to the operator of Diesel engines and is obtainable by writing to the Bristol Co., Waterbury, Conn.

Water Treatment and Metal Protection, Cooling Towers, Spray Ponds, Condensers and Heat Exchangers

Nalco System is discussed in three new bulletins. The first bulletin is entitled Softening Plant System and illustrates the use of the Nalco System in water softening plants. The second is entitled Internal Treatment and discusses the treating of feedwater in the boiler. A Scientific Boiler Water Treatment is the subject of the third bulletin. National Aluminate Corp., 6216 W. 66th Place, Chicago, Ill.

Water Softeners—A 16-page catalog covering the subject of Water Conditioning and Elgin Zeolite Water Softeners of the downflow, upflow, and the new Elgin Two-Flo type, also Elgin Elconite softeners for providing iron-free water, Elgin Aerator equipment, oil removal filters, and the Deconcentrator equipment for steam plants will be gladly supplied by the Elgin Softener Corp., Elgin, Ill.

Corrosion and Scale Prevention—by the Kirkaldy system is described in Bulletin EB-37-2 issued by Electrolytic Metal Protection, Inc., 247 Park Ave., New York, N. Y.

Water Cooling Equipment and Industrial Spray Nozzles are covered in a new complete water cooling catalog issued in three sections; 16-page Bulletin 190 covers induced draft spray cooling towers, 12-page Bulletin No. 170 covers type ED forced draft cooling towers; 16-page Bulletin 160 covers type R spray cooling towers; and 24-page Bulletin 150 covers industrial spray nozzles for water cooling, air washing and air conditioning. Binks Mfg. Co., 3114 Carroll Ave., Chicago, Ill.

Standards of the Tubular Exchanger Section—Covers mechanical, construction and thermal standards for shell and bare tube heat exchangers. The Standards contain data on exchanger shells, tube sheets, baffles, support plates, tubes, material specifications, fouling factors and thermal design data. Copies may be secured from the Secretary of the Heat Exchange Institute, C. H. Rohrbach, 90 West Street, New York City, at 75c each.

Tube Corrosion in the Marine and Power Fields is a book containing practical information on condenser tube corrosion, its primary causes and remedies; ferrule data; A.S.T.M. specifications; and descriptions of modern condenser tube manufacture. Copies will be sent to those interested by the Chase Brass & Copper Co., Waterbury, Conn.

Heating, Ventilation and Air Conditioning, Building Materials, Fans and Blowers

Flexible Concrete—A new Bulletin just issued by the Flexrock Co., 800 N. Delaware Ave., Philadelphia, Pa.

Norblo Square Type Air Filter—Bulletin 500-3 describing and illustrating the the square type air filter which is automatic and designed for continuous service. It is manufactured by the Northern Blower Co., Cleveland, Ohio.

Pre-fabricated Steel Frame Houses—Their construction is shown, details explained and finished appearance illustrated in this 20-p. bulletin entitled Pre-Fab Houses, issued by Harnischfeger Corp., 6785 W. Greenfield Ave., Milwaukee, Wis.

Air Conditioning Products is the title of Bulletin K, an 8-page catalog containing illustrations, brief descriptions and list prices of Friez complete range of instruments for the automatic controlling, indicating, recording, and testing and measuring of a broad variety of air conditions. Copies of this literature will be sent upon request to Julien P. Friez & Sons, Inc., Baltimore, Md.

Standard Methods Adopted for Centrifugal Fans and Blowers is a bulletin for the convenience of architects, engineers, and buyers of fan equipment. Formerly these standards were published in separate leaflets but were consolidated in one bulletin on the assumption that it would be of more value to the fan users by making available in one place all standards adopted by the National Association of Fan Mfgs., 5-208 General Motors Bldg., Detroit, Mich.

Piping and Fittings, Steam Specialties, Traps, Welding Equipment

Steam Hookups for Traps—A usefu reference booklet which discusses steam trap selection, gives details of Sarco heating specialties, shows the method for calculating steam trap sizes for different uses and illustrates the Sarco vacuum heating system. Diagrams are given for properly connecting central heating systems, air conditioning plants, unit heaters and process heating equipment such as cookers, water heaters, dryers, ironers; showing arrangement of piping and location of traps. Copies may be had on request to Sarco Co., Inc., 183 Madison Ave., New York, N. Y.

Stainless Steel Electrodes—A booklet containing considerable information regarding the various grades of Stainless Steels and the procedure for welding them, has just been published by the Page Steel and Wire Div. of American Chain & Cable Co., Inc., Monessen, Pa.

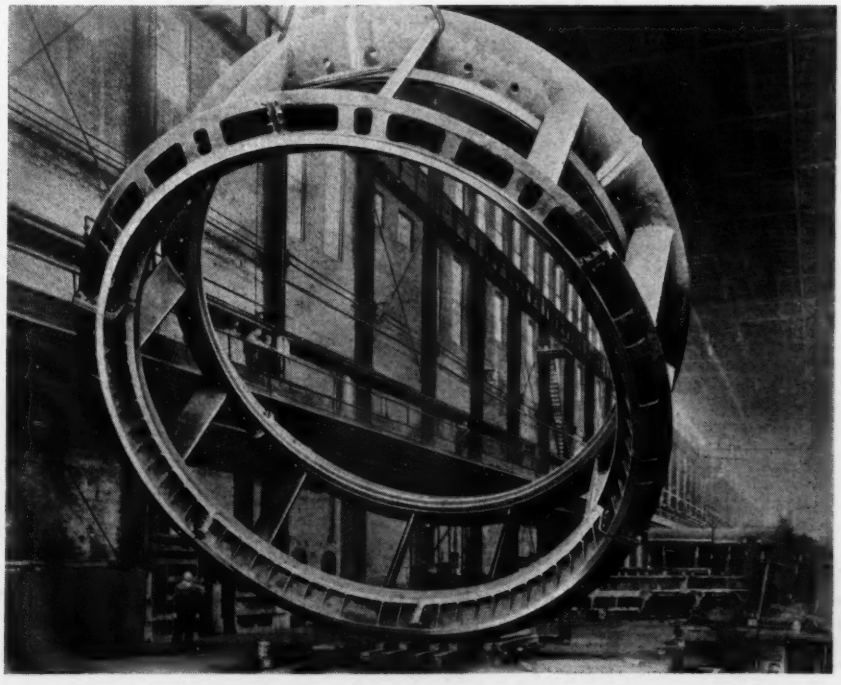
Arc Welding is a 24-page catalog which gives a complete discussion of the subject. It may be had by writing to Hobart Bros., Hobart Square, Troy, O.

Tube Couplings—For tubing from ¼ in. to 1 in. diameter, of copper or other easily worked material and with fittings of brass or other metal, packless, self-flaring tube couplings are described and illustrated, with lists of sizes and prices, in this informative catalog. Joints are made without the use of flaring tools, no packing is required, the flared tube end is supported by a strong backing ring, joints can be made on the job in close quarters, and are easily disconnected. The catalog, Bulletin 500, may be had on request from Packless Metal Products Corp., 37-14 29th St., Long Island City, N. Y.

BIG SPEED RING

Erecting shop view of assembled cast steel speed ring that will form part of one of the two 55,000-horse power hydraulic turbines under construction at Allis-Chalmers Mfg. Co's. Milwaukee plant for Pickwick Landing Project of T. V. A. This picture, showing partially machined bottom flanges, was taken just as this piece was being turned over for machining the top flanges. This turbine part, cast in six sections, has an outside diameter of 37 ft. 4 in., and over all height of 14 ft. 6 in. and a weight of 250,000 lb.

Provision is being made for six large hydro-electric units. The first two, forming the initial installation, are the ones now under construction in the shops of Allis-Chalmers Mfg. Co. and will be the largest propeller type hydraulic turbines in the United States. These turbines each will have a nominal rating of 48,000 horsepower under 43 feet head.



Power Transmission, Tools and Maintenance, Iron and Steel

High Temperature Digest of Steels—Presented in an 8½ by 11 in. booklet, in addition to the analyses and a short general discussion of the recommended applications of each steel, are data on creep strength, corrosion resistance, oxidation resistance, short-time high temperature properties, coefficients of linear expansion at various temperatures, charpy impact values at elevated temperatures, results of heat embrittlement tests, temperature stress embrittlement data, data on the stability of tensile properties and information on the structural stability of the steels.

These data are given for all steels normally used in the high temperature field, covering killed carbon steel, carbon-molybdenum steel, Silmo, DM, 2 per cent Cr-Mo, Sicromo 2¼, 4-6 per cent Cr-Mo, Sicromo 5 and 18-3 stainless steel. Copies of this new edition of The Timken Digest of Steels for High Temperature Service may be secured from the Timken Steel and Tube Division of The Timken Roller Bearing Co., Canton, Ohio.

High Temperature Steel Guide—Technical Bulletin No. 20, just prepared by the Timken Steel and Tube Division as a guide for Users of High Temperature Steels, presents technical data relating to the various properties of Timken Seamless Tubes, and lists all the properties of twelve steels commonly used in the form of tubes for high temperature service in the oil refining, power and allied industries. Salient factors affecting the selection of steels for use at elevated temperatures—corrosion, oxidation, strength and stability, are presented graphically, charts showing the effect of heating nine different steels in the air for 1000 hr. at 1000. 1250 and 1500 deg. F., together with the rate of creep for the same steels at 1000, 1100 and 1200 deg. A comparative price ratio summary is shown on the back cover of this informative new publication. Copies of Bulletin 20 may be secured by writing to the Timken Steel and Tube Division, The Timken Roller Bearing Co., Canton, Ohio.

Nickel Cast Iron—Uses of nickel alloy iron for automobile engines, for large plug valves, for corrosion-resisting equipment in paper mills, for wear resistance in hoist brake drums are among the item in November issue of Nickel Cast Iron News, sent out by International Nickel Co., Inc., 67 Wall St., New York, N. Y.

How to Select and Use Wrenches—A new booklet containing much helpful information to guide both the mechanic and tool buyer and including complete tables giving correct wrench openings for U. S., S.A.E., American Standard Nut and Cap Screw sizes. It is issued by I. H. Williams & Co., 75 Spring St., New York, N. Y.

Nickel Alloy Steel Tools—Use of such steels for hand tools such as wrenches, hammers, screw drivers, pliers, knives, chisels, shovels and the like is fully discussed in this 16-p. pamphlet and their advantages shown, with charts of the mechanical properties of various alloys. Issued by The International Nickel Co., Inc., 67 Wall St., New York, N. Y.

Condor Compensated Belts — 4-page bulletin illustrating and describing this product. In addition to discussing the reason for compensating rubber belts and the compensating principle the bulletin explains the advantage of the type of belt. The belting is a product of the Manhattan Rubber Mfg.—Division of Raybestos—Manhattan, Inc., Passaic, N. J.

Plastic Cement—Flex-o-Fix, a plastic adhesive compound for repairing insulation, rubber or fabric, filling cracks, and packing joints is described in a 16-p. booklet issued by Frund Products Co., 43 E. Ohio St., Chicago, Ill.

Machining Aluminum—A revised edition of a booklet containing detailed data on the machining of aluminum and its alloys. It will be of interest to machinists and engineers. Copies may be had upon request to the Aluminum Co. of America, Pittsburgh, Pa.

Roller Bearings—In a complete revision of the Timken Engineering Journal, a loose-leaf volume of 294 pages, contained in an 8½ by 11-in. 3-ring binder with stiff covers, is given a general discussion of types of Timken bearings available, ratings and bearing selection, methods for calculating bearing loads, and information as to bearing sizes and load carrying capacity. Accurate full and half size detail drawings are given for single row bearings up to 14 in. outside diameter.

Based on 40 yr. experience and data from elaborate research and test laboratories, information is given as to standard shims for both cup and cone adjusted bearings, on locknuts and washers, on annular groove closures and standard tubes. Methods of mounting, shaft and housing design and a section on cup and cone fitting practice are included, with specifications for lubricants to use with Timken bearings under a wide range of load, speed and temperature conditions.

Supplementary sections cover applications in special fields such as conveyors, shop trucks, mine cars, oil field equipment and the like. The Timken Roller Bearing Co., Canton, Ohio, will send a copy on request, and its engineering department will gladly cooperate with any manufacturer who contemplates application of anti-friction bearings to his product.

New Engineering Books

Oil Burners. By Kalman Steiner. Published by the McGraw-Hill Book Co., Inc., New York, N. Y. Size 6 by 9 in., 436 pages; cloth bound. Price $4.50.

A complete treatise on oil burner practice, embracing discussion of fundamental and advanced engineering and practical methods of oil burner design, construction, installation, operation and maintenance. This book describes basic concepts and essential engineering as well as actual practice. While modes change, engineering develops onward from what is already known and established. The material presented will probably be as applicable to the oil burner of a decade or two hence as to the products of today's manufacture.

Frequent repetition of text material has been avoided by segregation of classes of apparatus into their individual chapters. The author has tried to make the book as practical as possible so that it might be useful in the routine conduct of any of the technical departments of the industry.

Heating, Ventilation and Air Conditioning Fundamentals. By W. H. Severns. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. Size 6 by 9 in., 412 pages; cloth bound. Price $4.00.

Thorough treatment of the subject in not too technical language is offered in this book. Material included is sufficient for undergraduate courses usually given students in architectural and mechanical engineering. As well as typical examples of calculations, applicable theory is also included. Described and illustrated are pieces of equipment which are representative of commercial products. A sufficient supply of catalog data is given to enable the student to do some design work as part of his training. Although direct cast-iron radiators are no longer manufactured, but will still be in use in the years to come, attention has been given to their construction and performance. Factors affecting human comfort; heating boilers and appurtenance; the control of air temperature and humidity, are some of the 27 chapter headings.

Oil Fuels and Burners. By James A. Moyer. Published by McGraw-Hill Book Co., 330 West 42 St., New York, N. Y. Size 6 by 9 in., 367 pp., cloth bound. Price $4.00.

Recent developments in oil burners of the automatic type intended primarily for residence and apartment house use, prompted the preparation of this volume as a continuation of an oil burner course prepared by the author for the Education Bureau of the Navy.

It is intended as an informational manual for service men, salesmen, mechanics, electricians, and engineers. Included are many practical charts and diagrams for layout of oil-burner systems, automatic control devices, trouble charts of motors and generators, calculation of heating requirements, and heat insulation of walls, roofs, and floors in old as well as newly constructed buildings.

Many distributors and manufacturers now offer combined oil burner and air-conditioning equipment and a chapter on air-conditioning and air-conditioning tests has been added for completeness. The author feels that much cheap equipment offered for such service is inadequate and cautions against installations which can offer no permanent advantage to either the manufacturer or the person responsible for the installation.

Liquid Fuels, Their Manufacture, Properties, Utilization and Analysis. By Harold Moore. First edition, 264 pp., cloth, size 6 by 9½ in. illustrated. D. Van Nostrand Co., Inc., 250 Fourth Ave., New York. Price $8.00.

This book according to the authors' preface had its origin in a book entitled "Liquid Fuels for Internal Combustion Engines" published by the author in 1917. As this book is now completely out of date, it was impossible to re-edit or modify it and so the author produced an entirely new book, at the same time enlarging its scope to cover fuels for external combustion in addition to engine fuels. In order to keep the work within reasonable dimensions and to make it available to the great bulk of technical workers who are not actually specialists on the subject, it has been necessary to limit the field considerably, no attempt was made to prepare an exhaustive treatise. The volume is intended solely as a concise manual for those engaged in the oil trade, for engineers manufacturing or operating internal combustion engines and for those of the public who may wish to make a survey of the subject. It is a valuable and informative book which will give any user of fuel oil a rich background of knowledge on which to base his judgment in the selection of fuel oils for specific purposes.

UTILIZATION OF ELECTRIC ENERGY. By E. Openshaw Taylor. First edition, 342 pages, 5½ by 8½, cloth, illustrated. D. Van Nostrand Co., Inc., 250 Fourth Ave., New York, N. Y., 1937. Price $6.00.

As the author points out, although a number of books have been written on the utilization of electrical energy for various particular purposes such as electric traction, electro-chemistry, or illumination, there have been few, if any which cover the whole range of the more usual applications in a single volume. This book is an attempt to provide such a treatise, largely for the benefit of students but also of value to mechanical and civil engineers, who are becoming increasingly large users of electrical energy. Sales engineers also should find it useful. There are six general chapters as follows: Chapter I, Electric Drive (excluding traction); Chapter II, Electric Traction; Chapter III, Heating and Welding; Chapter IV, Electrolytic processes; Chapter V, Illuminating Engineering, and Chapter VI, Economic Aspects of Utilizing Electrical Energy. In addition to these chapters there is an appendix covering regulations and specifications, a bibliography and a final section containing answers to questions which are asked at the end of each chapter.

ARMATURE WINDING. By David P. Moreton, Carl H. Dunlap and L. R. Drinkall. 280 pp., cloth, size 5½ by 8¼, illustrated. American Technical Society, Chicago, Ill., 1938. Price $2.00.

This is an up-to-date, authentic and clearly written volume on the construction, winding and repairing of A. C. and D. C. motors and generators, with practical connection diagrams. The volume is particularly well adapted for purposes of home study and self instruction. Without sacrificing any of the essential requirements of thorough practical instruction, the authors have avoided many of the heavy technical terms and formulas of higher mathematics. The treatment will appeal not only to the technically trained expert but also to the beginner and the shop taught practical man who wishes to keep abreast of modern progress. All three authors have had long experience in teaching electrical engineering and they present the subject in a clear and concise manner.

CHEMICAL MIXTURES designed for the treatment of coal, with a view to making the coal burn better, really have little effect on the combustion of the fuel, it has been found by engineers of the Bureau of Mines, Department of the Interior, after the making of exhaustive tests. The results of the investigation are detailed in a bulletin just published by the Bureau. The Bureau took up this subject of investigation and thoroughly tested, both alone and in mixtures, all the chemicals known to have been marketed for this purpose, and many others, including water and chlorine. The chemicals were applied to a wide range of bituminous coals and to high-temperature and low-temperature cokes. The untreated and treated fuels were burned, under carefully controlled conditions, in overfeed and underfeed fuel beds at rates of burning varying from 1 to 50 lb. of fuel per square foot of grate per hour. Factors studied in detail were the effects of the chemicals on rates of ignition and combustion, on caking of coal in fuel beds, on tar and soot carried from the fuel beds, on soot deposited on surfaces of the furnaces and flues, on the emission of smoke, on the ash and clinker, and on the reaction of the sulphur in the fuels. The tests of this investigation and the deductions from them show that the possible fields of application of the pretreatment of fuels with any chemical are extremely limited. These findings do not in any way relate to the effectiveness of any material in reducing the dustiness of coal. The results of these investigations are given in Bulletin 404, "Burning of Coal and Coke Treated with Small Quantities of Chemicals," by P. Nicholls, W. E. Rice, B. A. Landry and W. T. Reid, copies of which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at a price of 15 cents each.

THE 1936-1937 report of the Oil and Gas Engines Subcommittee of the Prime Movers Committee of the Edison Electric Institute is available for distribution and may be obtained from headquarters of the Institute, 420 Lexington Ave., New York City. Price to non-members is $1.00 per copy. The report is trimmed to 8½ by 11½ in., covers 14 pp. and includes data on new installations on costs and discusses a number of operating problems.

SYMPOSIUM on Wear of Metals, consisting of six technical papers presented at an A. S. T. M. meeting in Philadelphia last April, has been reprinted in a separate bulletin. The price for the 105-page paper bound booklet is $1.25. Six papers and discussion cover: wear testing of metals; wear tests of cast iron; wear of metals from the automotive viewpoint; from the power equipment viewpoint; from the railroad viewpoint; and in the textile industry. Copies are available from the American Society for Testing Materials at 260 South Broad St., Philadelphia, Pa.

RETIREMENT UNITS FOR ELECTRIC AND GAS UTILITIES. 25 pp. each—State Law Reporting Co., 30 Vesey St., New York City. Defining a retirement unit as the smallest item of property which on replacement is required to be written out of the plant capital account, i.e. is not replaced through maintenance accounts, the list is prepared to create greater uniformity in accounting by public utilities as to replacements. All items which might be treated as retirement units are not listed because views are likely to differ, but all fairly large units on which there will be substantial agreement are included.

Because nature of the items replaced and conditions under which replacements occur are so varied, it is difficult to formulate any hard and fast rule for the accounting for replacements of parts of large structures or plants, hence judgment is an important factor in application of the instructions, which are intended to supplement the Uniform Systems of Accounts for Utilities. Items which are readily separated as units, which have a life of several years and whose cost is more than a few dollars would be considered as retirement units.

The cost of a retirement unit should include associated items which pertain only to that unit such as foundations, supports, ladders, guards, starting and control equipment, driving equipment, protective and measuring devices. Either the unit for electric utilities or that for gas utilities may be had from State Law Reporting Co. at 85 cents a copy for each pamphlet.

THE PRACTICE OF LUBRICATION. By T. C. Thomsen. Published by McGraw-Hill Book Co., New York, N. Y. Size 6 by 9 in., 638 pages; cloth bound. Price $6.00.

For many years lubrication has received but scant attention and existing operating standards leave considerable room for improvement. Few firms employ qualified chemists to assist in maintenance. Technical service embodying a highly trained staff of lubricating engineers was unheard of until recent years and is still considered an expensive luxury by most firms. Both oil suppliers and oil users are, however, beginning to realize that lubrication can no longer be left to guess work.

The changing attitude which has been taking place in the lubrication industry has necessitated a revision of the book and this, the third, edition has been largely rewritten and considerable new material added.

In producing a lubricating oil the oil refiner is less dependent than heretofore on the nature of the crude oil and there is a trend toward the introduction of inert lubricating material to give suitable viscosities. Not only can the refiner eliminate undesirable constituents of the oil more efficiently than was formerly the case, but by means of blending and the addition of other material can obtain characteristics which were formerly impossible. Extreme pressure lubricants and anti corrosion inhibitors as used in the automotive field are important developments.

Measuring devices and instruments have been subjected to active research. The internal combustion engine with its demand for better, cleaner and more economic lubrication has been responsible for considerable progress in the field, while the ever-widening use of circulating oil systems, not only for high speed engines but machinery in general, has brought about an increased use of centrifuges and filters. These new developments are covered in considerable detail in the text, the subject matter of which is divided into 36 chapters.

RESULTS OF MUNICIPAL LIGHTING PLANTS. Published by Burns & McDonnell Engineering Co., 107 West Linwood Blvd., Kansas City, Mo. 230 pages; paper bound. Price $2.00 postpaid.

The 1937 or fifth edition of this electric rate book shows what 511 representative cities pay for electricity under public ownership. More reports are contained in this edition than in any of the previous editions, although reports of some of the cities that have been given in the past had to be omitted.

This book is a unique and informative record of the rates, earnings, operating expenses, profits, kilowatt-hour production, valuation and other information pertaining to the use and cost of electricity. As the only record of its kind available it will be found indispensable to those interested in municipal plant operation.

Power Plant Construction News

Calif., Los Angeles—Swift & Co., 3750 Jewel Avenue, Vernon, Los Angeles, and Union Stock Yards, Chicago, Ill., plan installation of electric power plant in new meat-packing plant at first noted address, comprising six, five and four-story main units and adjoining one-story structures. Proposed to begin work late in December. Bids have been asked on building erection. Entire project will cost over $750,000. Construction department, Chicago address noted, is in charge.

Conn., New Britain—Cremo Brewing Co., Belden Street, plans installation of electric power equipment in new one and multi-story additions to plant. Cost close to $125,000. Proposed to begin work early in 1938. Edward F. Kawiak is engineer, in charge.

Ga., Brunswick — Hercules Powder Co., Delaware Trust Building, Wilmington, Del., has approved plans for new steam power house at chemical works at Brunswick. Cost reported close to $65,000, with equipment.

Ill., Beardstown—United States Engineer Office, Post Office Building, Canal and Van Buren Streets, Chicago, Ill., will receive bids until December 9 for control station, machinery and electrical equipment at New LaGrange lock and dam, Illinois River, near Beardstown, including gasoline-electric standby power unit, portable lighting units, electric towhaulage unit, hand-operated traveling bridge crane, pumping machinery and accessories, high-pressure air system, electric service feeders and controls, fuel oil supply system, complete electrical equipment and accessories (Circular 52).

Ill., La Salle—City Council will have plans prepared soon for new municipal electric light and power plant. A bond issue of $925,000 has been voted for project. H. M. Orr is mayor, in charge.

Iowa, Des Moines—Des Moines Ice & Fuel Co., 100 Maple Street, plans rebuilding of coal tipples at Eighteenth and Hickman Streets, recently destroyed by fire, with installation of hoisting, conveying, loading and other equipment. Loss estimated close to $50,000.

Kan., Kansas City—Midwest Cold Storage & Ice Corporation, Fifth Street and Kaw River, has approved plans for new three-story addition to cold storage and refrigerating plant. Cost over $100,000, with equipment. George E. Wells, Inc., Security Building, St. Louis, Mo., is consulting engineer.

La., Shreveport—Southwestern Gas & Electric Co., Shreveport, has approved plans for new addition to steam-electric generating plant in Arsenal Hill district, with installation to include a 15,000-kw. turbo-generator unit, two high-pressure boilers, 20,000-sq. ft. condenser, cooling tower and complete auxiliary equipment. Cost estimated over $1,000,000. Work will begin soon and is scheduled for completion in fall of 1938.

Md., Baltimore—Eastern Box Co., East Brooklyn, plans installation of electric power equipment in new addition to corrugated fiber box plant, for which superstructure will begin soon. Entire project will cost about $85,000.

Mich., Adrian—Southeastern Michigan Electric Co., Adrian, has plans maturing for new steam-electric generating station on local site. Company also will make extensions in transmission and distributing lines. Entire project is reported to cost over $250,000.

Mich., Bay City—Bay Refining Corporation, 205 Bearinger Building, Saginaw, Mich., recently organized, plans installation of power equipment in new oil refining plant at Bay City, where site is being secured. A boiler house and pumping station will be built. Entire project will cost close to $150,000. Company is affiliated with Gordon Oil Co., Hersee Building, Mount Pleasant, Mich.

Mich., Dearborn—Construction Service, Veterans' Administration, Washington, D. C., will receive bids for boiler plant at institution at Dearborn, including boilers and complete auxiliary equipment, pumps and other station equipment, radial brick stack, steel water tank and tower of 100,000-gal. capacity, outside distribution systems, etc., as per plans and specifications on file.

Mo., Kirksville—City Council is arranging call for bids for equipment for municipal water system, including pumping machinery and accessories, water-softening and other equipment. Cost about $60,000. Black & Veatch, 4706 Broadway, Kansas City, Mo., are consulting engineers.

Neb., Grand Island—City Council is considering extensions and improvements in municipal electric power plant, including installation of new generator, boiler and auxiliary equipment. Estimates of cost will be made soon. C. W. Burdick is light commissioner. Ray L. Harrison is city engineer.

N. J., Lyons—Construction Service, Veterans' Administration, Washington, D. C., will receive bids until December 28 for additions to sewage plant at institutions at Lyons, including tanks, pumping equipment, electrical and mechanical apparatus, electric elevators, etc., as per plans and specifications on file.

N. J., Orange—E. Bilhuber, Inc., 154 Ogden Avenue, Jersey City, N. J., manufacturer of drugs and pharmaceuticals, plans installation of electric power equipment in new three-story and basement plant on Crane Street, Orange, where site has been selected, totaling about 100,000 sq. ft. of floor space. Cost over $125,000.

N. Y., Oneida—Oneida Community, Ltd., Oneida, has plans maturing for new steam power house at local plant. Cost close to $40,000, with equipment. Work will be carried out by separate contracts and is scheduled to begin soon.

N. C., Asheville—Swift & Co., Union Stock Yards, Chicago, Ill., meat packers, plan installation of electric power equipment in new three-story branch plant on Meadow Road, Asheville, where site has been acquired. Entire project reported to cost close to $100,000.

Ohio, Warren — Sunlight Electrical Co., Warren, manufacturer of fractional horsepower motors, a unit of General Motors Corporation, General Motors Building, Detroit, Mich., plans installation of electric power equipment in new plant at Warren, for which work is scheduled to begin soon. Entire project will cost in excess of $400,000. John B. Estabrook is general manager.

Okla., Hollis—Common Council will have plans prepared soon for new municipal electric light and power plant. A bond issue of $135,000 has been approved for project.

Okla., Marlow — Common Council plans extensions and improvements in municipal electric power pant, incuding installation of 700-hp. Diesel engine-generator unit and auxiliary equipment. Proposed to begin work at early date.

Okla., Purcell — Common Council is considering extensions and improvements in municipal electric power plant, including installation of a 1000-hp. Diesel engine-generating unit and auxiliary equipment. Proposed to begin work soon.

S. D., Freeman—City Council will receive bids until December 8 for equipment for new municipal electric power plant. Also for an electrical distribution system. Cost close to $100,000. Financing has been arranged. Buell & Winter Engineering Co., Insurance Exchange Building, Sioux City, Iowa, is consulting engineer.

Tenn., Chattanooga—Lookout Oil & Refining Co., Kirkland Avenue, has approved plans for new steam power plant at local cottonseed oil mill and will begin work soon. Cost close to $125,000, with equipment. Company is a subsidiary of Armour & Co., Union Stock Yards, Chicago, Ill.

Texas, Dallas — Canada Dry Ginger Ale, Inc., 100 East Forty-second Street, New York, N. Y., plans installation of electric power equipment in new mechanical-bottling works on Moxley Avenue, Dallas, where site has been selected. Entire project will cost over $200,000. P. B. Montgomery, 913 Akard Street, Dallas, is engineer.

Texas, Mercedes — Stokely Brothers & Co., 2002 South East Street, Indianapolis, Ind., canned food products, plan installation of electric power equipment in new branch plant at Mercedes, where tract of 5 acres of land has been acquired. Cost about $100,000.

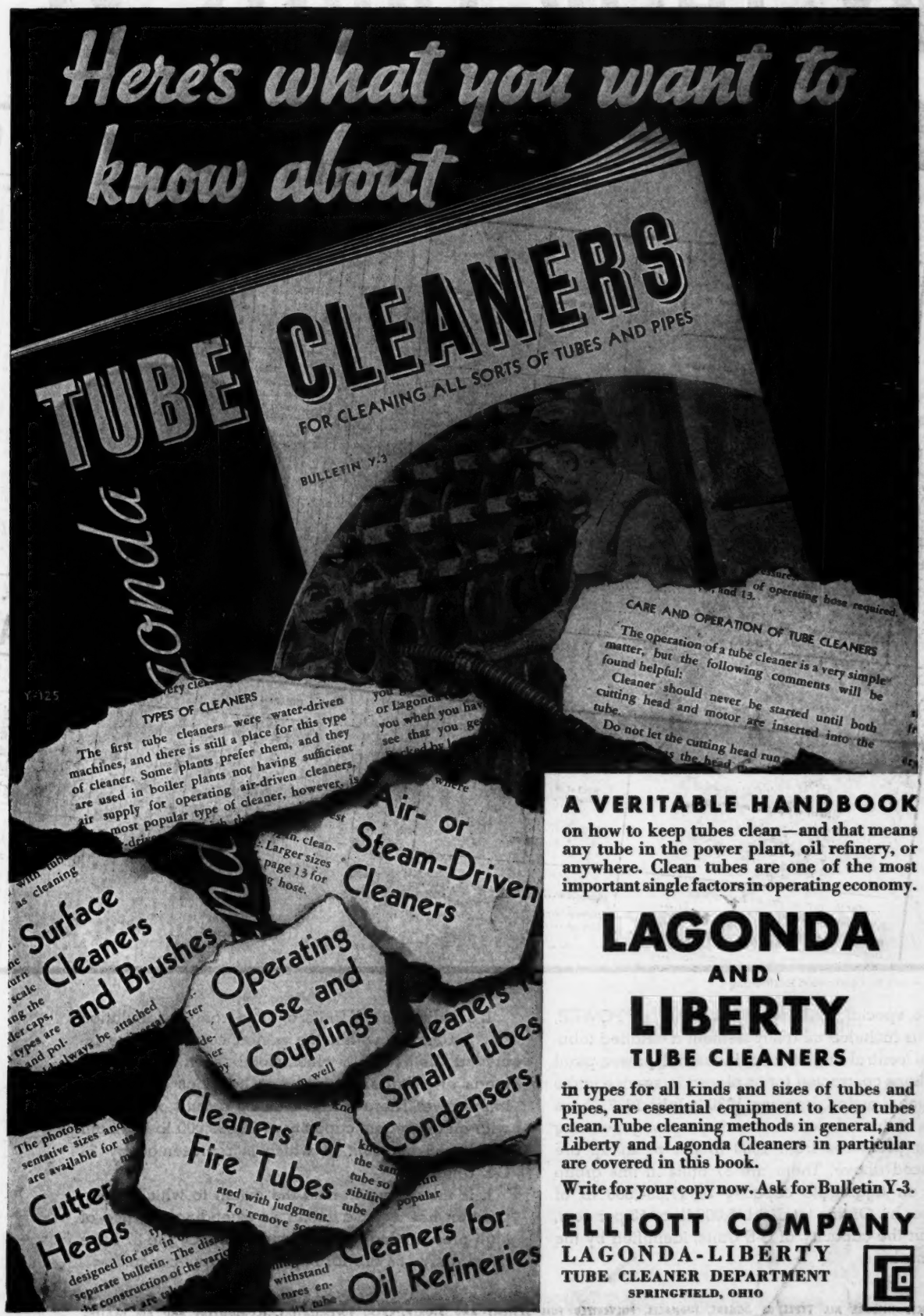
Texas, Smiths Bluff—Pure Oil Co., 35 East Wacker Drive, Chicago, Ill., plans installation of power equipment in connection with expansion and improvements in oil refining plant at Smiths Bluff. Entire project is reported to cost in excess of $2,500,000.

Wash., Spokane—Shell Oil Co., Shell Building, San Francisco, Calif., has plans under way for new boiler plant at bulk oil terminal on North Greene Street, Spokane. Cost over $50,000, with equipment. Proposed to begin work early in 1938.

Wash., Tacoma — Hooker Electrochemical Co., Tacoma, with main offices at 60 East Forty-second Street, New York, N. Y., plans installation of electric power equipment in new addition to plant at Tacoma, on which work will begin soon. Entire project will cost over $100,000. McKim, Mead & White, 101 Park Avenue, are architects, and Alan Porter Lee, Inc., 136 Liberty Street, consulting engineer, both New York, N. Y.

Wis., La Crosse—State Board of Normal School Regents, Capitol Building, Madison, will take bids early in December for new one and three-story steam power plant, 45x85 feet., at State Teachers' College, La Crosse, for central heating service at institution. Cost about $95,000. Arthur Peabody, Madison, is state architect, in charge.

Wis., River Falls—Wilkins & Kay, River Falls, have plans under way for new cold storage and refrigerating plant. Cost estimated close to $30,000.


Here's what you want to know about
TUBE CLEANERS
FOR CLEANING ALL SORTS OF TUBES AND PIPES
BULLETIN Y-3
Lagonda
Y-125
TYPES OF CLEANERS
The first tube cleaners were water-driven machines, and there is still a place for this type of cleaner. Some plants prefer them, and they are used in boiler plants not having sufficient air supply for operating air-driven cleaners, most popular type of cleaner, however, is
CARE AND OPERATION OF TUBE CLEANERS
The operation of a tube cleaner is a very simple matter, but the following comments will be found helpful:
Cleaner should never be started until both cutting head and motor are inserted into the tube.
Do not let the cutting head run
Air- or Steam-Driven Cleaners
Surface Cleaners and Brushes
Operating Hose and Couplings
Small Tubes Condensers
Cleaners for Fire Tubes
Cutter Heads
Cleaners for Oil Refineries

A VERITABLE HANDBOOK

on how to keep tubes clean—and that means any tube in the power plant, oil refinery, or anywhere. Clean tubes are one of the most important single factors in operating economy.

LAGONDA AND LIBERTY TUBE CLEANERS

in types for all kinds and sizes of tubes and pipes, are essential equipment to keep tubes clean. Tube cleaning methods in general, and Liberty and Lagonda Cleaners in particular are covered in this book.

Write for your copy now. Ask for Bulletin Y-3.

ELLIOTT COMPANY
LAGONDA-LIBERTY
TUBE CLEANER DEPARTMENT
SPRINGFIELD, OHIO

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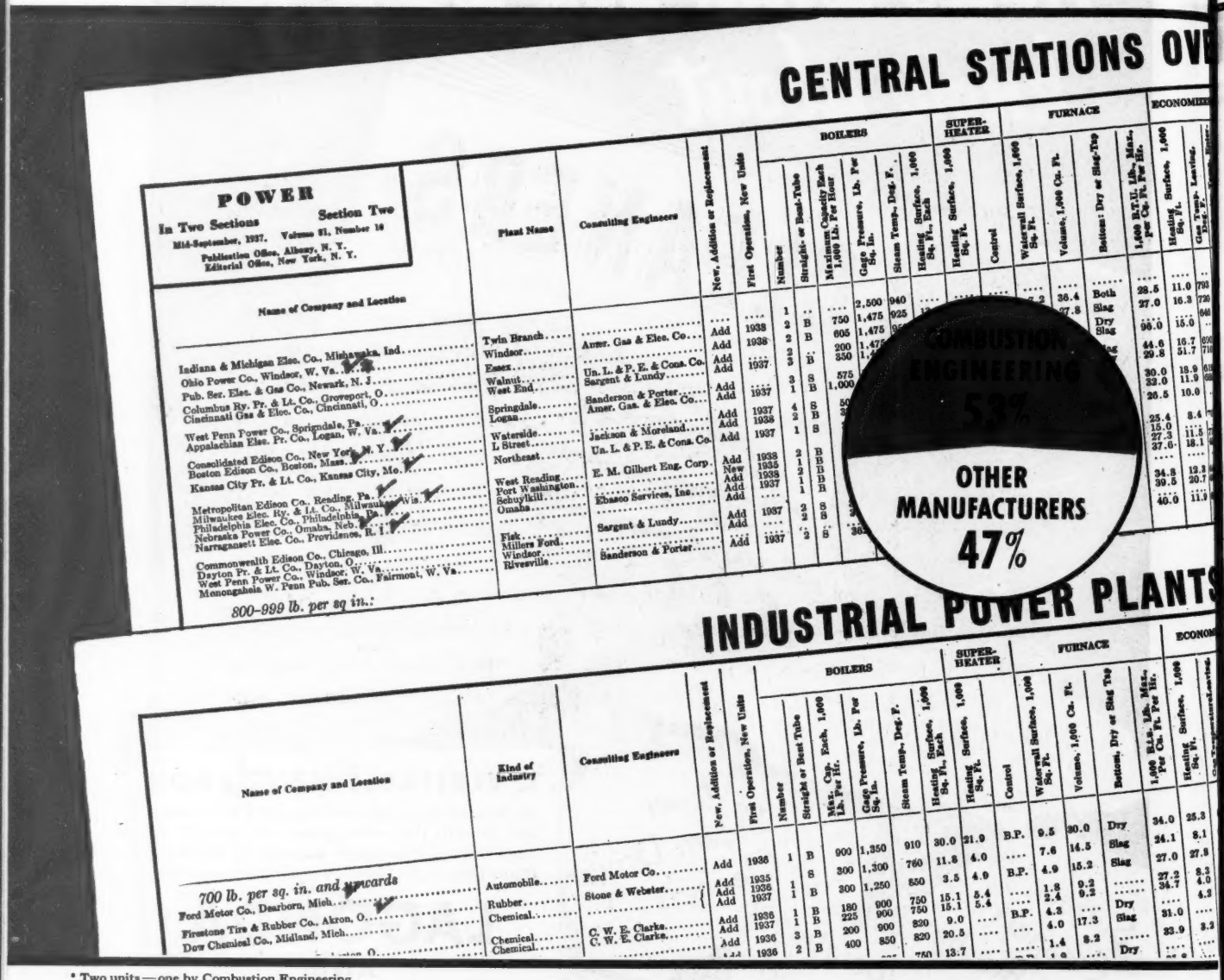
"BY THEIR FRUITS YE



POWER
In Two Sections — Section Two
Mid-September, 1937. Volume 81, Number 10
Publication Office, Albany, N. Y.
Editorial Office, New York, N. Y.

CENTRAL STATIONS OVE

Name of Company and Location	Plant Name	Consulting Engineers	New, Addition or Replacement	First Operation, New Units	BOILERS: Number	BOILERS: Straight- or Bent-Tube	BOILERS: Maximum Capacity Each 1,000 Lb. Per Hour	BOILERS: Gage Pressure, Lb. Per Sq. In.	BOILERS: Steam Temp.-Deg. F.	BOILERS: Heating Surface, 1,000 Sq. Ft., Each	SUPERHEATER: Heating Surface, 1,000 Sq. Ft.	SUPERHEATER: Control	FURNACE: Waterwall Surface, 1,000 Sq. Ft.	FURNACE: Volume, 1,000 Cu. Ft.	FURNACE: Bottom: Dry or Slag-Tap	FURNACE: 1,000 B.t.u. Lib.-Max. Per Cu. Ft. Per Hr.	ECONOMIZER: Heating Surface, 1,000 Sq. Ft.	ECONOMIZER: Gas Temp.- Leaving, Deg. F.
Indiana & Michigan Elec. Co., Mishawaka, Ind.	Twin Branch		....	....	1	..	....	2,500	940	....	....	....	....	....	Both	....	....	....
Ohio Power Co., Windsor, W. Va.	Windsor	Amer. Gas & Elec. Co.	Add	1938	2	B	750	1,475	925						Slag	28.5	11.0	793
Pub. Ser. Elec. & Gas Co., Newark, N. J.	Essex		Add	1938	2	B	605	1,475							Dry	27.0	16.3	720
Columbus Ry. Pr. & Lt. Co., Groveport, O.	Walnut	Un. L. & P. E. & Cons. Co.	Add	....	2	B	200	1,475							Slag	99.0	15.0	....
Cincinnati Gas & Elec. Co., Cincinnati, O.	West End	Sargent & Lundy	Add	1937	2	B	350	1,4								44.6	16.7	690
					3											29.8	51.7	710
West Penn Power Co., Springdale, Pa.	Springdale	Sanderson & Porter	Add	1937	1	B	575									30.0	18.9	618
Appalachian Elec. Pr. Co., Logan, W. Va.	Logan	Amer. Gas. & Elec. Co.	Add	....			1,000									33.0	11.9	688
					4													
Consolidated Edison Co., New York, N. Y.	Waterside	Jackson & Moreland	Add	1937	2	B										25.4	8.4	7
Boston Edison Co., Boston, Mass.	L Street	Un. L. & P. E. & Cons. Co.	Add	1938	2	B										15.0	....	
Kansas City Pr. & Lt. Co., Kansas City, Mo.	Northeast		Add	1937	1	S										27.3	11.5	7
																37.6	18.1	
					2											....	....	
Metropolitan Edison Co., Reading, Pa.	West Reading	E. M. Gilbert Eng. Corp.	Add	1938	2	B										34.8	12.3	
Milwaukee Elec. Ry. & Lt. Co., Milwaukee, Wis.	Port Washington		New	1935	2	B										39.5	20.7	
Philadelphia Elec. Co., Philadelphia, Pa.	Schuylkill		Add	1938	2	B										....	....	
Nebraska Power Co., Omaha, Neb.	Omaha	Ebasco Services, Inc.	Add	1937	1	B										40.0	11.9	
Narragansett Elec. Co., Providence, R. I.			Add	....														
					2													
Commonwealth Edison Co., Chicago, Ill.	Fisk	Sargent & Lundy	Add	1937	2	S												
Dayton Pr. & Lt. Co., Dayton, O.	Millers Ford		Add	....														
West Penn Power Co., Windsor, W. Va.	Windsor	Sanderson & Porter	Add	1937	2	S												
Monongahela W. Penn Pub. Ser. Co., Fairmont, W. Va.	Rivesville																	

800–999 lb. per sq in.:

COMBUSTION ENGINEERING 53%

OTHER MANUFACTURERS 47%

INDUSTRIAL POWER PLANTS

Name of Company and Location	Kind of Industry	Consulting Engineers	New, Addition or Replacement	First Operation, New Units	BOILERS: Number	BOILERS: Straight or Bent Tube	BOILERS: Max. Cap. Each, 1,000 Lb. Per Hr.	BOILERS: Gage Pressure, Lb. Per Sq. In.	BOILERS: Steam Temp.-Deg. F.	BOILERS: Heating Surface, 1,000 Sq. Ft. Each	SUPERHEATER: Heating Surface, 1,000 Sq. Ft.	SUPERHEATER: Control	FURNACE: Waterwall Surface, 1,000 Sq. Ft.	FURNACE: Volume, 1,000 Cu. Ft.	FURNACE: Bottom, Dry or Slag Tap	FURNACE: 1,000 B.t.u. Lib.-Max. Per Cu. Ft. Per Hr.	ECONOMIZER: Heating Surface, 1,000 Sq. Ft.	ECONOMIZER: Gas Temperature Leaving
700 lb. per sq. in. and upwards																		
Ford Motor Co., Dearborn, Mich.	Automobile	Ford Motor Co.	Add	1936	1	B	900	1,350	910	30.0	21.9	B.P.	9.5	30.0	Dry	34.0	25.3	
			Add	1935	1	S	300	1,300	760	11.8	4.0	....	7.6	14.5	Slag	24.1	8.1	
Firestone Tire & Rubber Co., Akron, O.	Rubber	Stone & Webster	Add	1936	1	B	300	1,250	850	3.5	4.0	B.P.	4.9	15.2	Slag	27.0	27.9	
			Add	1937	1					15.1	5.4	....	1.8	9.3	.....	27.2	8.3	
Dow Chemical Co., Midland, Mich.	Chemical									15.1	5.4	....	2.4	9.3	.....	34.7	4.0	
			Add	1936	1	B	180	900	750	9.0	....	B.P.	4.3	17.3	Dry	....	4.2	
		C. W. E. Clarke	Add	1937	1	B	225	900	750				4.0		Slag	31.0	....	
	Chemical	C. W. E. Clarke	Add	1936	3	B	200	900	820	20.5	....	....				33.9	3.2	
	Chemical		Add	1936	2	B	400	850	820				1.4	8.2	.....		....	
			Add	1936					750	13.7	....	....	1.8	....	Dry			

* Two units—one by Combustion Engineering

In the special Mid-September issue of POWER, there was included as a supplement a detailed tabulation of central station and industrial power plant installations contracted for or placed in service in the approximate period, January, 1936 to July, 1937. Those portions of this tabulation covering steam generating units for pressures from 1000 lb per sq in up are reproduced above. There are 37 units in this group having an aggregate capacity of 17,354,000 lb of steam per hr. Of this total, 9,145,000 lb or **53** *per cent*, represent the capacity of C-E Units, identified by the check marks.

If 5 additional C-E Units, omitted from the tabulation but purchased within the period covered, were included, the extent to which Combustion Engineering leads all other manufacturers becomes even more impressive. There would then be a total of 42 units with an aggregate capacity of 19,899,000 lb of steam per hr, **59** *per cent* of which is represented by 23 C-E Units.

It is interesting to note the extent to which superposition has been a factor in extending the use of high pressure-high temperature units. Of the 37 units listed above 34 are for superposed application.

C-E PRODUCTS INCLUDE ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

COMBUSTION

SHALL KNOW THEM"

The worth of any manufacturing organization's service to its field finds evidence not only in the extent and success of its conventional installations, but also, and more significantly, in the contributions it has made to progress and in the extent of its identification with the most notable of contemporary installations.

For those whose needs are adequately met by conventional boiler units, Combustion Engineering offers the most extensive line of equipment on the market—virtually every established type of boiler, fire tube as well as water tube, and a line of furnace, firing and related equipment adequate for any fuel or operating conditions. C-E Boiler Units of conventional but thoroughly modernized designs are supplying the steam requirements of plants in every section of the country with exceptional economy and dependability.

For those whose needs require units of special design, justifying the highest caliber of engineering and the best manufacturing facilities available, Combustion Engineering offers, as a measure of its ability to meet such needs, the facts presented on the opposite page, evidencing this Company's contemporary position with respect to the top classification of modern steam generating units.

Further evidencing Combustion Engineering's ability to provide the best in design and equipment are the facts—

that the boilers last purchased for the largest industrial, central station and central heating boiler plants in the world are C-E Boilers.

that a C-E Unit is the sole source of steam supply for the central station holding the present world's record for efficiency.

that of the eight steam generating units in the world capable of producing a million or more pounds of steam per hour, six are C-E Units.

that two C-E Units hold world's records for steam production — 1,270,000 lb in one hour and an average of 805,000 lb per hr for a month, respectively.

that an installation of three C-E High Pressure Boiler Units has an availability record of 96.3 per cent over a four-year period.

that the first boiler unit to produce steam above 900 F for regular commercial use was a C-E Unit, equipped with an Elesco Superheater.

We invite you to judge the merits of C-E design and equipment for unit capacities from 1000 to 1,000,000 or more lb of steam per hr on the basis of our contemporary work.

A-385

COMBUSTION ENGINEERING COMPANY, INC., 200 MADISON AVENUE, NEW YORK, N. Y. • CANADA: COMBUSTION ENGINEERING CORPORATION,

ENGINEERING

"At this rate, the oil

.... GULFCREST OIL Demonstrates Phenomenal Stability in Turbine Systems of Leading Plants and in Laboratory Tests

"This is the most remarkable experience we have ever had with a turbine oil," says the manager of a big power plant in which Gulfcrest oil is in service. "Deterioration has been so slight that, at this rate, the oil will far outlast the turbine."

Many power plant operators who have had Gulfcrest oil in service a year or more are prepared to make similar statements. But of equal interest are the results of laboratory tests shown in the graphs below. They clearly illustrate the phenomenal stability of Gulfcrest oil as compared with what have been heretofore considered as good turbine lubricants.

Where, under accelerated oxidation tests, a normally good commercial turbine oil begins to oxidize rapidly at about 200 hours, Gulfcrest oil shows practically no deterioration in several months' continual punishment in the testing apparatus. Its marked superiority is so definitely established that there is practically no basis for comparison between this Alchlor processed turbine oil and others. (Gulfcrest is refined by the same exclusive Gulf process as Gulfpride—the world's finest motor oil.)

We suggest that you talk with a Gulf engineer about this remarkable turbine oil at your first opportunity.

GULF OIL CORPORATION
GULF REFINING COMPANY
GENERAL OFFICES: GULF BUILDING, PITTSBURGH, PA.

4 REASONS

why Gulfcrest Oil is the Turbine Lubricant of Unparalleled Quality

1 *Refined by the ALCHLOR Process.* This famous process, patented and owned exclusively by Gulf, is the most thorough and effective method for removing chemically active hydrocarbons as well as the general run of impurities present in all crudes.

2 *Highest resistance to oxidation.* This famous ALCHLOR Process synthesizes and rearranges the molecular structure of certain hydrocarbons, resulting in a finished product of greater stability. GULFCREST Oil stands alone in its high resistance to oxidation.

3 *Highest resistance to acidity and sludge.* Because of the elimination of oxidation catalysts in addition to the unparalleled refining power of the Alchlor Process, these oils form less gum and deposits, less emulsion and sludge, when mixed with water over a period of several years continuous operation, than any other turbine oil of which we have record.

4 *Highest kilowatt-hour performance.* Because Alchlor not only makes possible an oil more thoroughly refined and homogeneous but also creates anti-oxidants, these oils have great resistance to deteriorating influences and are longer lived. Less makeup oil is required.

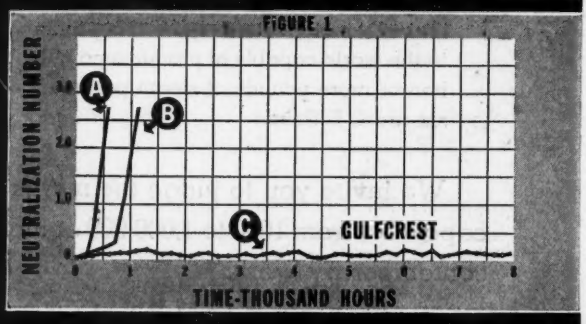
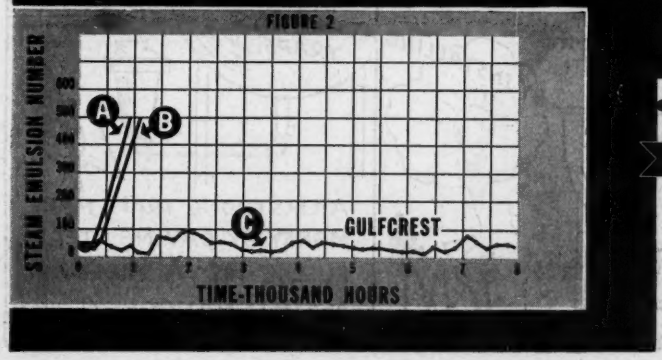


Fig. 1 shows the effect of accelerated oxidation at 210° F. in the presence of copper, iron and water on the *neutralization numbers* of three different turbine oils. Curve C shows the marked superiority of Gulfcrest oil (This test was made in the laboratory of the Gulf Research & Development Company.)

will outlast the turbine.."

SAYS POWER PLANT MANAGER

Power plant operators who keep the Gulf engineer "in the picture" have the benefit of his cooperative service—and assurance of highest lubrication efficiency—at all times.



GULF INDUSTRIAL LUBRICATION

MAKERS OF GULF NO-NOX ETHYL GASOLINE AND GULFPRIDE OIL

Fig. 2 shows the effect of accelerated oxidation at 210° F. in the presence of copper, iron and water on the *steam emulsion numbers* of three different turbine oils. Curve *C*—representing Gulfcrest oil—shows the marked superiority of this Alchlor treated lubricant (This test was made in the laboratory of the Gulf Research & Development Company.)

STEAM TRAP NEWS

Published by ARMSTRONG MACHINE WORKS, 810 Maple St., Three Rivers, Mich.

TRAPSHOTS
By TRAPPER JOE

You musta run across the fella that's always lookin' for the pot of gold at the end of the rainbow—the fella that thinks in big money but never has any—the fella that can't be bothered savin' little amounts 'cause they don't mean anything. He's always ready for the killin'—goin' to make one big haul—goin' to find one way of solvin' all his money problems. *Didja ever notice how that fella usually ends up where he started—his head full of big talk—an' his pockets empty?*

* * *

Seems to me that fella's got a telescope out looking over the horizon for money makin' plans when he ought to have a microscope and be lookin' right under his own feet—'cause that's where his money's gonna come from. No—but he can't be bothered with small stuff like that.

* * *

That's why you're gettin' along and he's not. You're lookin' right at home to see where you can start makin' your pile. Now, it seems to me that it's the same way with most any man. If he takes inventory of his own business, he'll find plenty of places to start makin' money by savin' it. Not big money all at once—but there's 100 pennies in every dollar—and if you catch the pennies, the dollars'll take care of themselves.

* * *

Didja know that a steam leak through a 1/8" orifice could cost you $315.00 a year?

THE QUESTION BOX

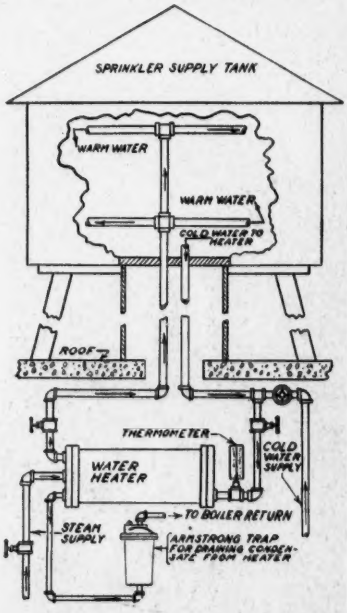
How many pounds of steam will a 2-inch pipe deliver at 100 lbs. pressure with the pressure drop not exceeding a pound per 100 ft. of run?

You can find the answer on page 25 of the new fourth edition of the Armstrong Steam Trap Book. Ask for your copy of this 32 page compendium of useful information about condensate drainage, steam traps, etc. It answers dozens of common questions and gives detailed information about Armstrong steam traps for every purpose. A postcard request is all that's necessary.

APPROACHING COLD WAVE PERILS UNPROTECTED SPRINKLER TANKS!

An ice-locked sprinkler tank can't protect you against a sudden unexpected fire. If you have not already done so, by all means check up on the heating hook-up that keeps your tank from freezing. Remember, this is a service that is easily overlooked after a long period of inactivity.

The accompanying diagram illustrates one method of steam-heating sprinkler supply tanks in cold weather. An important part of this installation is the Armstrong steam trap which guarantees the removal of condensate as soon as it forms in the heater, thus assuring warm water at all times. This is certainly a place where it pays to use the most dependable steam trap you can get.



Eliminates Vapor-Locking In Centrifugal Pumps

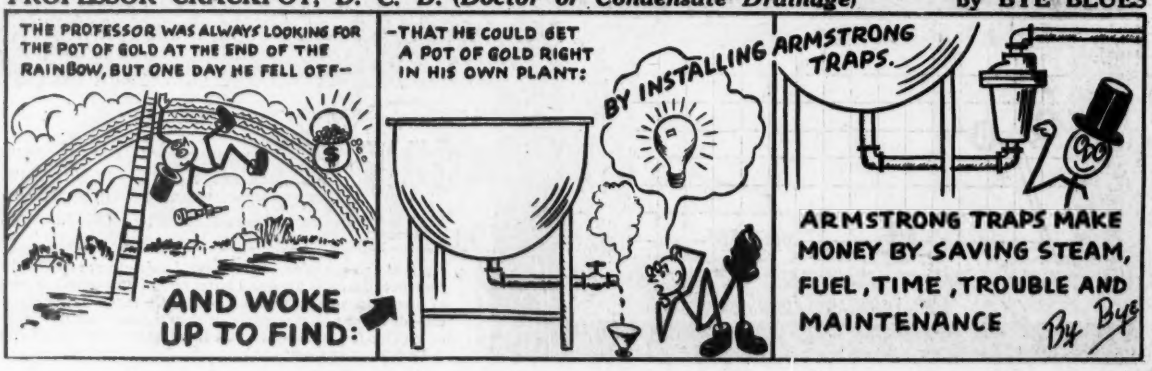
An economical and completely satisfactory method of automatically eliminating vapor-locking in centrifugal pumps was recently devised by W. E. Hopton, Syracuse, N. Y., for one of his Armstrong trap customers.

The customer was having trouble in pumping gasoline, the discharge being intermittent because of accumulation of vapor in the top of the pump case. Although the discharge was resumed when the petcock was opened, this meant paying constant attention to the pump. So Mr. Hopton installed an Armstrong No. 21 air trap as shown in the accompanying diagram and no trouble whatsoever has been experienced since.

SAVE TON OF COAL A DAY

When R. Thomas & Sons Co., Lisbon, Ohio, makers of porcelain insulators, installed 66 Armstrong traps in their plant, the results were even better than they hoped for. Drying oven temperatures became uniform and steady. The maintenance man saved nineteen days of time each month. Production speeded up. And coal consumption dropped from 5000 lbs. to 3000 lbs. a day. Two boilers now handle the load that formerly kept three busy.

PROFESSOR CRACKPOT, D. C. D. (*Doctor of Condensate Drainage*) by BYE BLUES

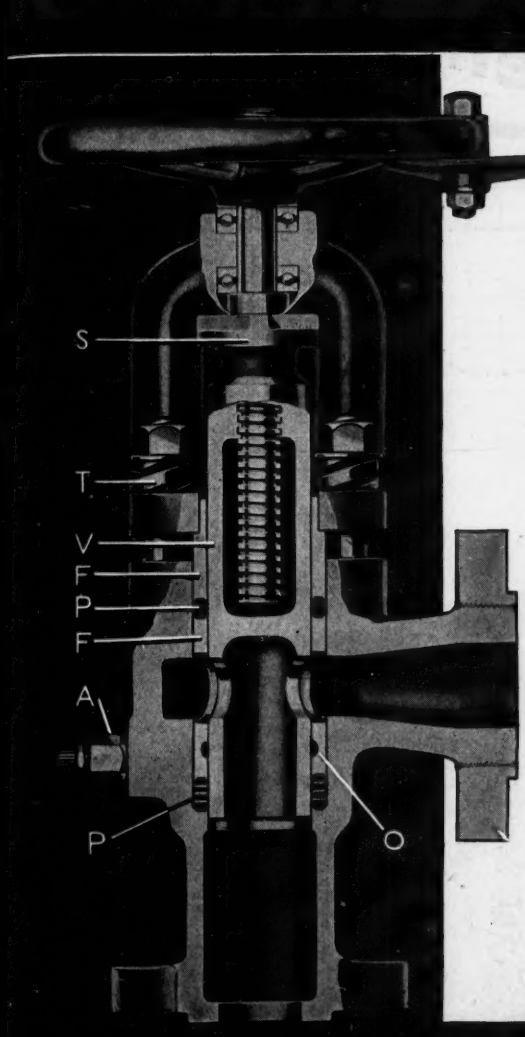

THE PROFESSOR WAS ALWAYS LOOKING FOR THE POT OF GOLD AT THE END OF THE RAINBOW, BUT ONE DAY HE FELL OFF—
AND WOKE UP TO FIND:
—THAT HE COULD GET A POT OF GOLD RIGHT IN HIS OWN PLANT:
BY INSTALLING ARMSTRONG TRAPS.
ARMSTRONG TRAPS MAKE MONEY BY SAVING STEAM, FUEL, TIME, TROUBLE AND MAINTENANCE
Bye Bye

YARWAY EQUIPPED...

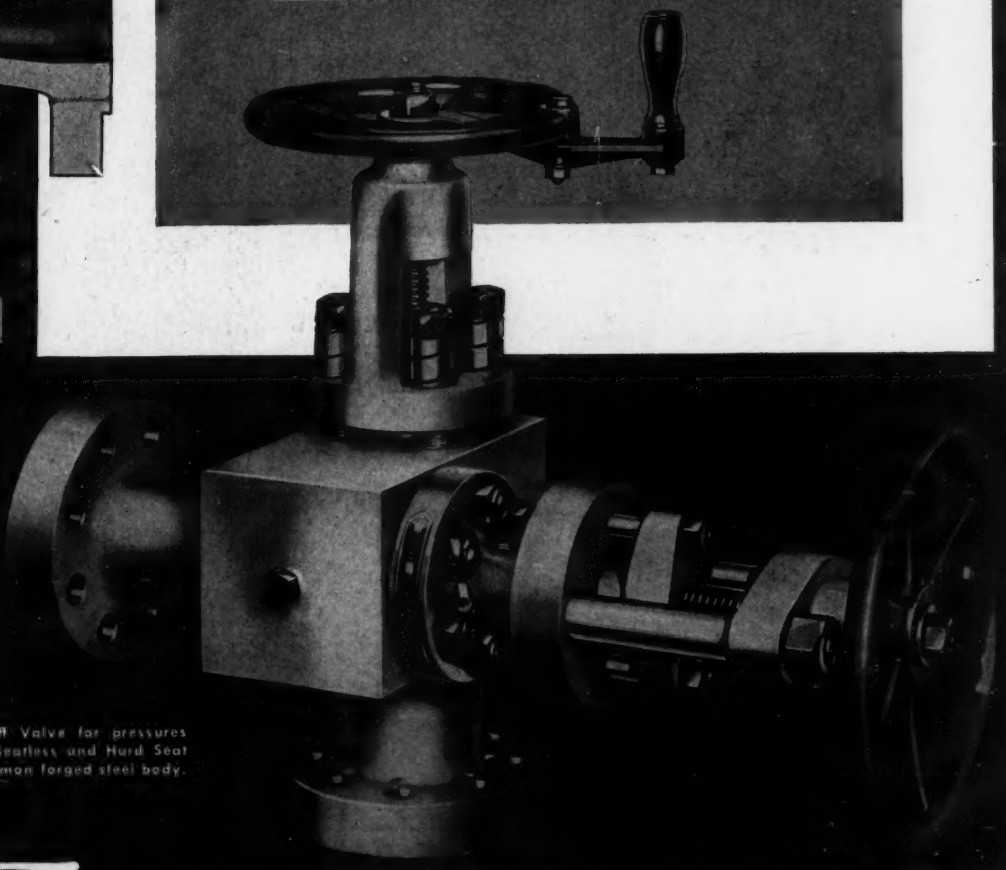
A Mark of Good Engineering

Yarway Blow-off Valves are used singly or in tandem in more than 10,000 plants in 67 different industries . . . Regarded as a standard of quality by leading steam plant designers and builders of steam generating equipment . . . Selected for Federal, State and Municipal Institutions . . . Built for all pressures up to 2,000 lbs.

YARNALL-WARING COMPANY
114 Mermaid Ave. Philadelphia



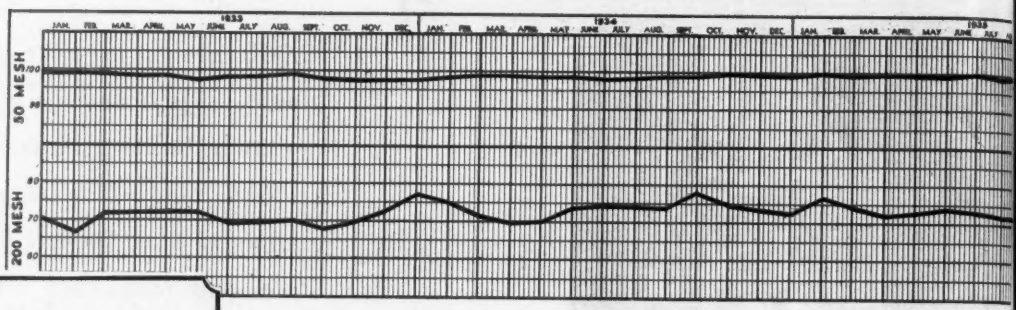
Yarway Seatless Blow-off Valve. Operation: After Valve is closed, shoulder S on plunger V contacts with upper follower gland F, forcing it down into body and compressing packing P above and below port. Annular groove O connects with Alemite fitting A for lubricating plunger and packing. Yoke springs T maintain continuous pressure through follower gland F on packing rings P.



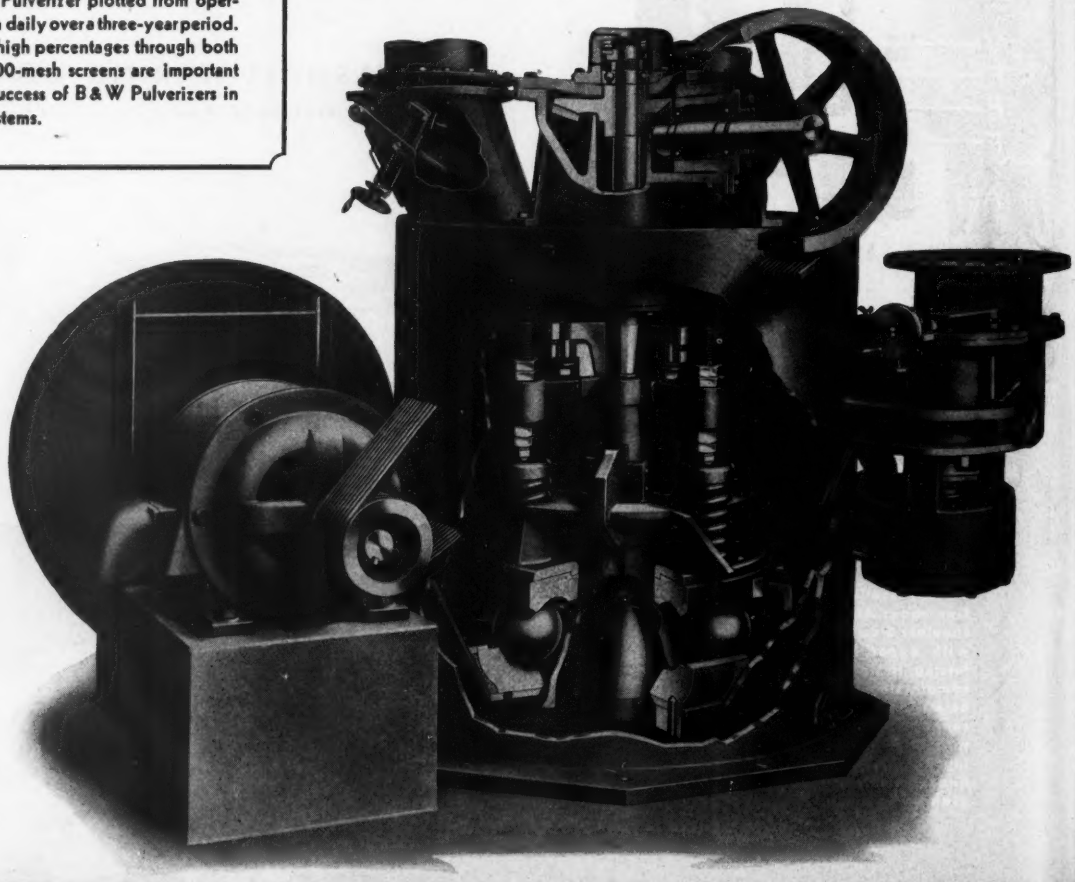
Yarway Unit Tandem Blow-off Valve for pressures from 600 lbs. to 1500 lbs. A Seatless and Hard Seat Valve combination using a common forged steel body.

YARWAY BLOW-OFF VALVES

The Ball-Bearing Grinding Element of

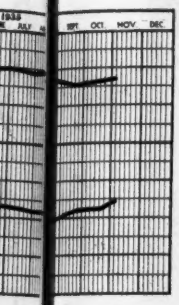


Above is a typical record of fineness of output of a B&W Pulverizer plotted from operating data taken daily over a three-year period. The consistent high percentages through both the 50- and 200-mesh screens are important factors in the success of B&W Pulverizers in direct-firing systems.



THE BABCOCK

the B & W Pulverizer –



Sustains Fineness . . .

normally the balls remain spherical and continue to roll smoothly in the grinding rings

Reduces Outages . . .

grinding elements are of high-grade wear-resisting materials

Maintains Efficiency . . .

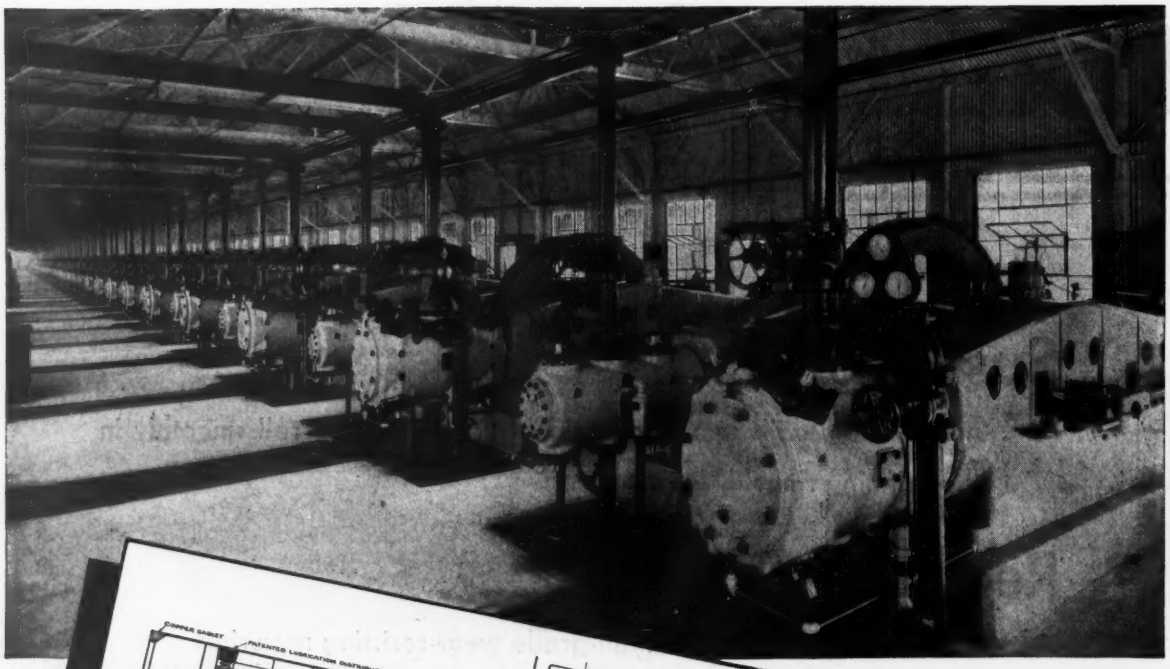
wear of grinding parts does not reduce fineness or increase unburned-carbon loss

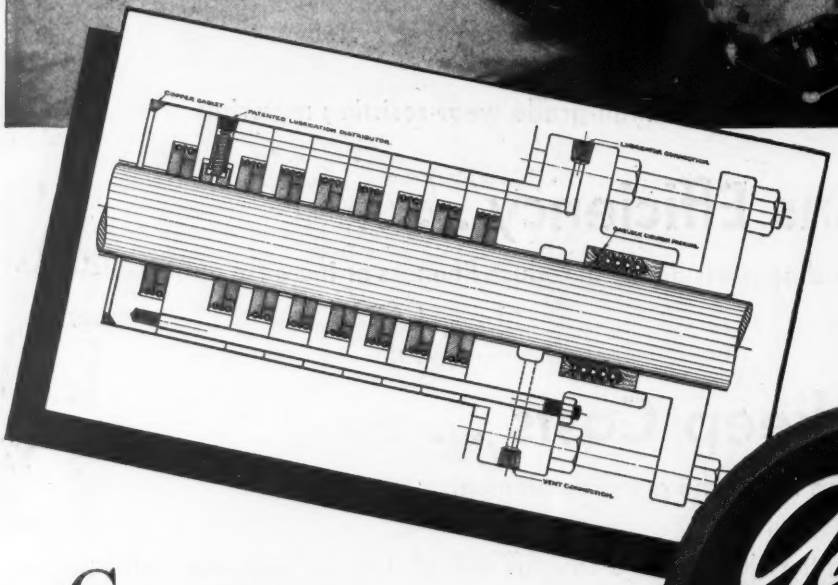
Cuts Upkeep Costs . . .

through long life of the grinding elements

The dollar and cents value of these savings will, of course, vary over rather wide limits. In a typical case it amounted to almost ten per cent of the cost of the pulverizer during the life of the grinding elements. These and other money-saving advantages of the B&W Pulverizer and the B&W Direct-Firing System are outlined in Bulletin G-19... copies on request.

THE BABCOCK & WILCOX COMPANY
85 LIBERTY STREET NEW YORK, N. Y.





Above: A modern compressor station. *At Left:* Typical installation of GARLOCK 875 Combination High Stage Gas Compressor Metal Packing.

Garlock METAL Packing

GARLOCK Metal Packings are giving dependable, year-after-year service on all kinds of compressor rods, gas engines, steam engines, pumps and other equipment where metal packings are desired. Correctly designed by metal packing engineers and precision built of the finest, selected metals, GARLOCK Metal Packings are as economical as they are efficient. Write for catalog.

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

In Canada: The Garlock Packing Company of Canada, Limited, Montreal, Que.

1887-1937 FIFTIETH ANNIVERSARY

THE STANDARD PACKING OF THE WORLD

Only

MIDWEST

WELDING ELLS give you LONG TANGENTS

TANGENT

TANGENT

"GIVE" is used advisedly in the heading above because the important advantages of the long tangents available only on Midwest Ells cost you nothing extra. Tangent length is ¼ of the nominal fitting diameter. A 12" ell has tangents 3" long.

advantages:

1. Possible to more quickly and accurately line up the pipe and fitting.
2. Easier to use lining-up clamps than when fittings have very short tangents or none at all.
3. Remove weld from the point of maximum bending stress (the end of the arc).
4. Reduce the amount of pipe required.
5. Frequently eliminate a short nipple and the extra circumferential weld it requires.
6. Possible to slip on forged steel flanges and weld them front and back.

Other Features

LONG RADIUS

Radius is 1½ times nominal diameter instead of being only equal to nominal diameter. Larger radius makes welding more convenient and reduces installation time. It also saves pipe and eliminates excessive pressure drop.

DIMENSIONAL ACCURACY

and uniformity not otherwise possible result from final working in compression.

UNIFORM WALL THICKNESS

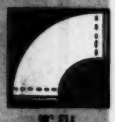
results from manufacturing process which is used exclusively by Midwest.

STRESS RELIEVED

Midwest Ells are first made slightly over-size. They are then reheated to a forging heat and reduced to correct size in compression.

GREAT STRENGTH

Destruction tests have proved Midwest Ells always as strong as the corresponding pipe.



MIDWEST
PIPING & SUPPLY COMPANY, Inc.

Main Office: 1450 So. Second St., St. Louis, Mo.

Plants: St. Louis, Passaic (N. J.) and Los Angeles • Sales Offices: Chicago—946 Marquette Bldg. • Houston—1716 Second National Bank Bldg. • Los Angeles—320 Anderson St. • New York—(Eastern Division) 30 Church St. • Tulsa—533 Mayo Bldg.

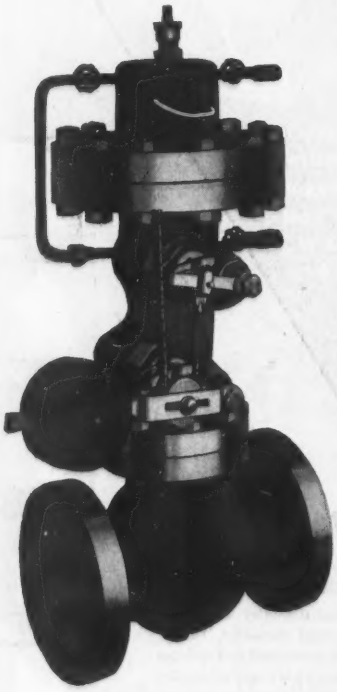
MIDWEST

WELDING FITTINGS IMPROVE PIPING DESIGN AND REDUCE COSTS

You could almost call it

MICROMETER ADJUSTMENT

of your boiler water level



So accurately does the new COPES Flowmatic Regulator control boiler water level, even on the most violent load swings, that you could almost call it micrometer adjustment. It can provide a practically constant level for all ratings or a slightly higher level on heavy loads than on light — exactly the right characteristic to make your boiler operation safest and most efficient. Automatically, dependably — with no more than routine supervision. May we tell you where you can check results now being obtained by users of steam-flow type COPES Regulators? Or send you Bulletin 409, which illustrates and describes the new COPES Flowmatic?

NORTHERN EQUIPMENT CO., 1212 GROVE DRIVE, ERIE, PA.

Feed Water Regulators, Pump Governors, Differential Valves, Liquid Level Controls, Reducing Valves and Desuperheaters
BRANCH PLANTS IN CANADA, ENGLAND, FRANCE, GERMANY, AUSTRIA, ITALY. REPRESENTATIVES EVERYWHERE

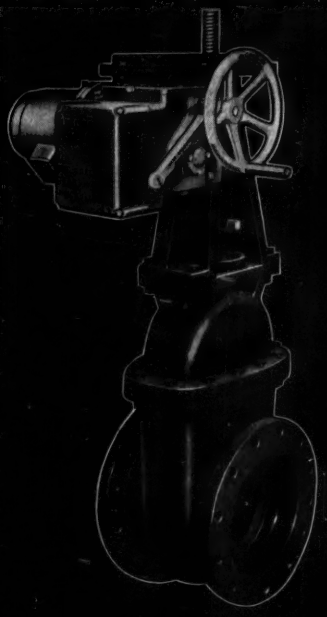
COPES

FEEDS BOILER ACCORDING TO STEAM FLOW•AUTOMATICALLY

FLOWMATIC

★ REGULATOR

ALWAYS ON GUARD AGAINST This or This



For installations where it is not advisable to attach the control unit directly to the valve yoke, Floor Stand Controls can be supplied. Usually these are mounted directly over the gate stem, although other locations are possible.

Bent Valve Stems . . . Valve Gates chipped or damaged otherwise, are serious matters that cause expensive replacements, inconvenient shut-downs and general disruption of schedules. And, these are but some of the troubles that can follow improper valve seating or the valve gate's meeting an obstruction during the closing operation.

Philadelphia Limitorque Control gives absolute assurance against these dangers. Whenever undue resistance to the movement of the valve gate may be encountered Limitorque becomes inoperative, immediately disconnecting the motive power.

Philadelphia Limitorque Control is an efficient, mechanically operated device for opening and closing globe, gate, Penstock and rotary plug valves, as well as many other operations.

Limitorque is readily adapted to any make of valve. Furthermore, it can be installed on existing equipment.

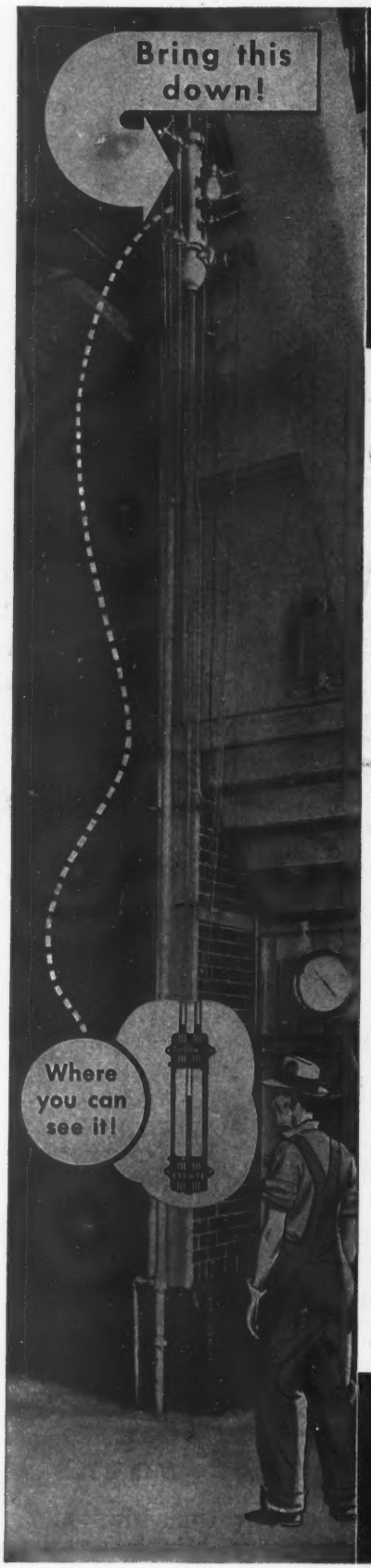
Write for recent catalog.

PHILADELPHIA *Limitorque*

PHILADELPHIA GEAR WORKS

Industrial Gears and Speed Reducers

ERIE AVENUE & "G" STREET, PHILADELPHIA, PA.



Reliance EYE-HYE

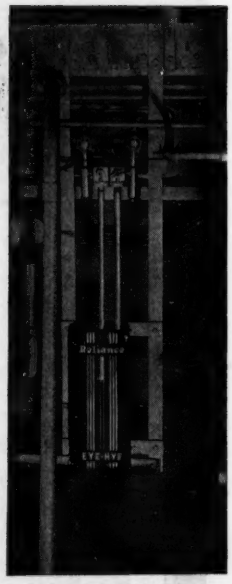
Remote-Reading Water Gage

Gives You Safe, Convenient, Instant Water Level Control

EYE-HYE, the remarkable new Reliance Remote-Reading Water Level Gage, brings that high-on-the-boiler, hard-to-see water gage right down to the boiler-room floor in front of your nose.

Because of its scientific accuracy, it shows you the true water level in the boiler. At a glance, you see the bright green indicator liquid, illuminated and clear — you **know** exactly where the water level is. Saves climbing to see, avoids uncertainty.

The modern design case of the EYE-HYE adds to your pride in an efficient instrument board. It's easy to install — tubing comes down around corners, girders, piping. Positive U-tube principle with non-mixing Vizzene liquid. Proved dependable—same engineering and manufacture that set the record of nearly 150,000 Reliance boiler alarms on duty and not one known to fail in an emergency.



Reliance High Pressure EYE-HYE in the boiler room of the Celluloid Corporation, Newark, N. J.

Investigate this sound investment in safe, efficient, economical boiler operation. Write today for the facts.

THE RELIANCE GAUGE COLUMN CO., 5902 Carnegie Ave., Cleveland, O.

TRADE MARK REG. IN U.S. PAT. OFF.

Reliance

SAFETY WATER COLUMNS

Beech-Nut

Finds Good Use for THIS Neat Little Set of G-E Instruments

A view of the Beech-Nut Packing Company's plant located at Canajoharie, in upper New York State. Here are made gum, candy, and mints; peanut butter and preserves; bacon, spaghetti, and other well-known Beech-Nut products.

OFFICIALS of the Beech-Nut Packing Company credit their engineers with showing the way to improved products and reduced power costs.

But the engineers will start immediately to tell you about the testing set of G-E instruments and transformers which were purchased in May, 1935.

They will tell you—enthusiastically—about how these instruments have been used to determine the actual loading of motors—both in the power house and in the two plants—and of feeders so that loads may be distributed to the best advantage. And especially to check machine processes to help maintain the uniformity and high quality of products.

They have been working fine, too, the engineers will continue—not giving a bit of trouble; and we're satisfied that they have already paid for themselves.

Why Be Instrument-minded?

If you, as a plant engineer, are instrument-minded, you are also management-minded. By this we mean that you are constantly on the alert for ways to better processes, improve quality, cut costs, and thus boost profits.

In this work, electric testing instruments will help—in fact they are indispensable. Make full use of those you now have. They will amply repay for the time you spend. If you need others, let a G-E instrument specialist help you to select new ones that will best meet the needs of your plant. Address your nearest G-E sales office, or General Electric Company, Dept. 6-201, Schenectady, N. Y.

The material for this advertisement was obtained through the courtesy of Mr. H. L. Diefendorf, Engineering Department, who has charge of the instruments, Mr. Thomas Cairns, Chief Electrical Superintendent, and Mr. D. R. Grant, Production Manager of the Canajoharie Plant.

THIS set of G-E instruments is similar to those selected by the Beech-Nut Packing Company for use in its Canajoharie Plant and purchased in May, 1935. It is a versatile set, widely applicable, and sells at a reasonable price.

Reading from left to right, are a recording wattmeter, an indicating ammeter, and two current transformers. All are of the portable type so that they may be easily carried around the factory.

If you need instruments, similar to these, they may be purchased from General Electric in a wide variety of ratings. Both recording and medium-sized indicating instruments are available as voltmeters, ammeters, milliammeters, and wattmeters.

In order to limit its instrument investment and provide great flexibility in current ratings, Beech-Nut uses G-E portable instrument transformers. General Electric manufactures a complete line for all applications.

Prices and complete information on all types of G-E instruments are given in Catalog GEA-602. For a copy, address nearest G-E sales office or General Electric Company, Dept. 6-201, Schenectady, N. Y.

430-64

GENERAL ELECTRIC

A SINGLE OBJECTIVE ..... *Economy*

A SINGLE RESPONSIBILITY IN ACHIEVING IT

The Republic Flow Meters Co. offers a complete manufacturing and engineering service in the field of measurement and control. We will be glad to co-operate with you in the solution of any metering or control problem, whether it involves a single instrument or the automatic control of an entire process or plant. Your inquiries will involve no obligation on your part.

ELECTRICAL FLOW METERS. For metering the flow of steam, water, gas, air, oil, brine, etc. The reading instruments, indicator, recorder and integrator, are remote reading and can be supplied singly or in any combination desired.

MECHANICAL FLOW METERS. A simple mechanical meter, indicating, recording and integrating the flow of fluids.

CO_2 METERS. Provides a continuous record of per cent CO_2 in flue gas measured by the orsat method. Furnished with either mechanical or remote reading indicator and recorder.

DRAFT INSTRUMENTS. Indicating or recording types in single or multiple units. Furnished in all standard ranges of draft and pressure.

THERMOMETERS. A long distance, expansion type thermometer with either single or multiple pen recorder.

LIQUID LEVEL INSTRUMENTS. Remote reading indicators and recorders. Also provided with various types of alarm and control devices.

MULTI-POINT INDICATORS. Will indicate, on separate horizontal scales from two to sixteen units of draft, pressure, flow, temperature, CO_2, etc., in any combination desired.

MULTIPLE RECORDERS. Will record on a wide strip chart, from three to six separate records of flow, temperature, CO_2, pressure, etc., in any combination desired.

PANEL BOARDS. Master instrument and control panels are designed and built for any combination of instruments and controls desired.

BOILER CONTROLS. A centralized, automatic system for controlling steam pressure, combustion, furnace pressure, excess pressure, boiler level, etc. Automatically regulates the fuel and air input to a boiler in measured proportions and in a fixed ratio for the entire load range.

DESUPERHEATERS. A venturi type desuperheater wherein the rate of water flow is controlled by the steam flow in correct proportion to reduce the steam temperature to the degree desired.

REGULATING VALVES. Turbine type valves designed for regulating the pressure and flow of liquids and gases including high pressure superheated steam. Built in accordance with A.S.A. standards for all pressures up to 1,500 lbs. per sq. in.

REGULATORS. For the automatic control of pressure, draft, rate of flow, rate of fuel feed, speed of rotation, liquid level, etc. For proportioning two pressures or flows. Regulators may be either air or oil operated.

STEAM ACCUMULATORS. Designed and built to meet your specific requirements for the storage of high and low pressure steam.

DESCRIPTIVE DATA BOOKS MAILED UPON REQUEST

★

REPUBLIC FLOW METERS CO.

2224 DIVERSEY PARKWAY . CHICAGO . ILLINOIS

"SINCE MY LAST CALL ON THE ABOVE PLANT I FIND"

—*A Typical Beginning* of some 25,000 impartial reports by Socony-Vacuum Field Engineers...to guide us in refining oils suited to actual Plant conditions

How Socony-Vacuum Engineering Service can save money in your plant:

1. Curb losses that boost power consumption and costs.
2. Decrease maintenance.
3. Improve production results by greater machine efficiency.
4. Lower lubrication costs.
5. Help your men find ways to devise important economies.

TONIGHT—in hotels across the country—Socony-Vacuum Field Engineers are writing their reports!

News of what Gargoyle Lubricants did today *in service*.

News of new methods...problems.

These hard-boiled facts leave no loopholes. Gargoyle Lubricants must meet operating conditions!

Because they do—Socony-Vacuum "Correct Lubrication" has saved millions in 110 different industries. Improved production. Lowered power, maintenance and oil costs.

The advice of a Socony-Vacuum Engineer may result in surprising economies in your own plant. A word from you will bring him there.

SOCONY-VACUUM

CORRECT LUBRICATION

GARGOYLE Lubricants

SAVES MONEY FOR INDUSTRY

Read what 71 Years' Lubricating Experience...the Greatest in the Oil Business...can do for You. See Next Page.

THIS MARKETING POLICY MEANS "CORRECT LUBRICATION" FOR EVERY TYPE OF PLANT

INDUSTRY ALMOST ALWAYS FINDS that the controlled use of high-grade Gargoyle Lubricants pays for itself many times over and that they actually cost less to use than ordinary lubricants.

But, for such equipment as does not justify the highest-grade lubricants, Socony-Vacuum Engineers will always recommend a lower-priced lubricant when consistent with true economy.

Socony-Vacuum, with a complete line of products, can supply the lubricants best fitted for the requirements of the individual lubricating job as determined by specific operating conditions.

Socony-Vacuum Engineers bring you years of world-wide experience and direct cooperation with manufacturers of equipment. Lubrication Profit is the inevitable result.

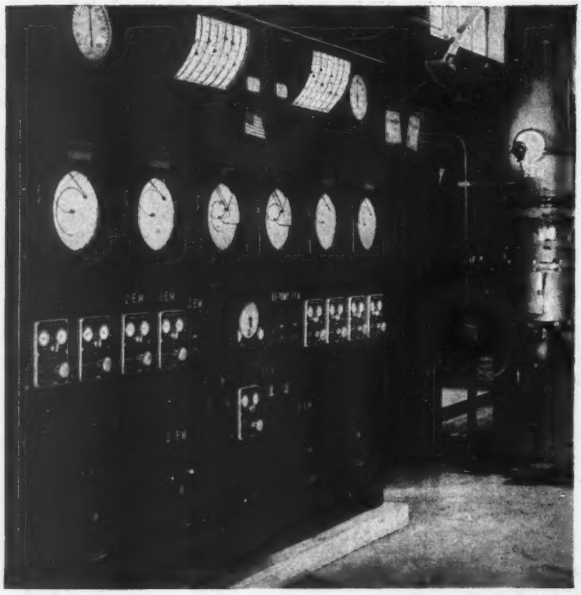
SEND FOR THE SOCONY-VACUUM REPRESENTATIVE: *The services of a trained Socony-Vacuum Engineer are available at all times in helping your men to solve lubrication problems.*

SOCONY-VACUUM OIL CO.
INCORPORATED

STANDARD OIL OF NEW YORK DIVISION · WHITE STAR DIVISION · LUBRITE DIVISION · WHITE EAGLE DIVISION
WADHAMS OIL COMPANY · MAGNOLIA PETROLEUM COMPANY · GENERAL PETROLEUM CORPORATION OF CALIFORNIA

GARGOYLE
Lubricants

MOREHEAD PRESENTS
"STAR PERFORMERS FOR
STEAM USERS"
LIQUIVATOR
Acclaimed the safest, most efficient method for handling liquids, including steam drainage, boiler feeding and water circulation. *Automatically* returns condensate at original high temperatures with amazing savings in steam, water and fuel. The metering type provides accurate check of boiler evaporation against fuel consumption.
BACK-TO-BOILER SYSTEM
Tested and proved in thousands of plants all over the world, this unit brings relief from high operating costs. Drains all steam-heated apparatus; returns condensate to boilers with matchless savings.
EXHAUSTEAM PURIFIER
Delivers clean, dry, completely purified exhaust steam that may safely be substituted for live steam in heating, drying, cooking and processing. Resulting condensate is suitable for boiler feeding.
MOREHEAD
MANUFACTURING
COMPANY
DETROIT • MICHIGAN
MOREHEAD MANUFACTURING CO.,
Dept. PE, Detroit, Michigan
Without obligation, send me information on units checked below:
☐ Liquivator ☐ Exhausteam Purifier
☐ Back-To-Boiler System
Name
Address
City State



Bailey Combustion Control installed on two 80,000 lb. per hour capacity pulverized coal fired integral-furnace boilers at Libbey-Owens-Ford Glass Co., Toledo, O.

DAILY EFFICIENCIES INCREASE TO TEST STANDARDS

At Libbey-Owens-Ford Glass Co. Bailey Meter Control automatically operates steam generating equipment to maintain test economies at all times

To secure a full return from an investment in new boilers, water-cooled furnaces, pulverizers, stokers and other major equipment, it is necessary that they be operated to deliver maximum combustion economy—not only during tests, but continuously day in and day out.

At Libbey-Owens-Ford Glass Co., as in numerous other modern steam plants, this duty has been assigned to Bailey combustion control. This complete control incorporates the Steam Flow—Air Flow boiler meter as an integral part of the system so that even minute changes in fuel—air ratios are measured and automatically corrected for even as they tend to occur.

Bailey Meter Control makes possible the maintenance of boiler test standards in every-day operation because it is a complete system which (1) automatically maintains desired steam pressure; (2) automatically maintains most economical fuel—air ratio; (3) automatically maintains desired furnace draft; (4) automatically maintains division of load among boilers.

Details on this sturdy, inexpensive, air-operated control system are contained in bulletin No. 102-A. Your copy will be mailed, without obligation, upon request.

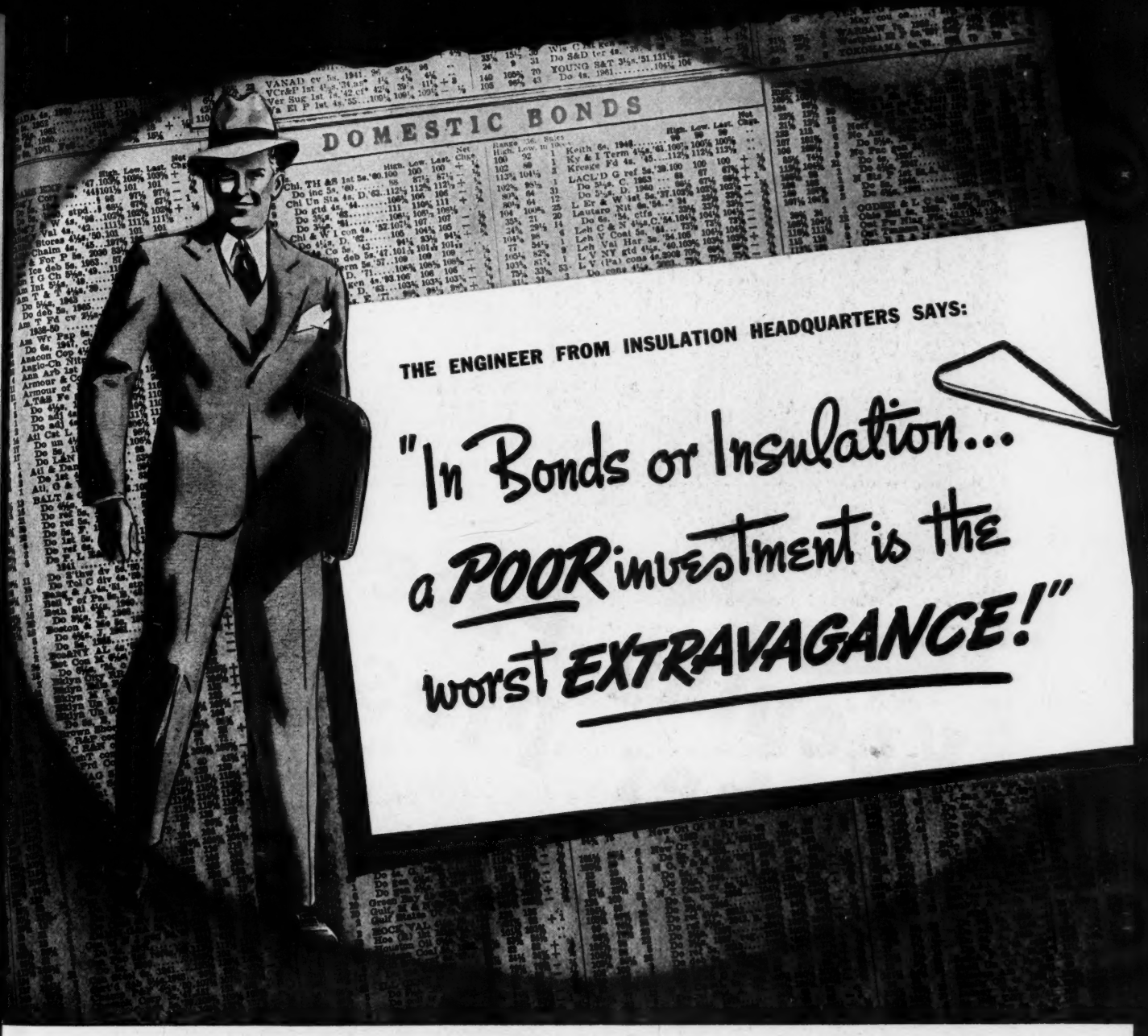
BAILEY METER COMPANY
1040 IVANHOE ROAD • CLEVELAND, OHIO
Bailey Meter Company Limited, Montreal, Canada A-35-1

BAILEY PRODUCTS

BOILER METERS • COMBUSTION CONTROL • FEED WATER CONTROL • PRESSURE REDUCING AND DESUPERHEATING CONTROL • SUPERHEAT CONTROL • MULTI-POINTER GAGES • SMOKE DENSITY RECORDERS • RECORDERS FOR PRESSURE, TEMPERATURE AND LIQUID LEVEL • FLUID METERS FOR STEAM, WATER AND GAS.

BAILEY METER CONTROL

The Complete Combustion Control System


DOMESTIC BONDS
THE ENGINEER FROM INSULATION HEADQUARTERS SAYS:
"In Bonds or Insulation... a POOR investment is the worst EXTRAVAGANCE!"

"BONDS... being bought on an investment basis... obviously stand or fall on the security and size of the returns they promise.

"And insulations that are inefficient or unduly perishable... like poor investments in bonds... are the worst extravagance!"

This statement, coming from Insulation Headquarters, sums up 75 years of experience, devoted to intensive research and to gaining the broadest possible experience in the field of industrial insulation. It presents a buying point of view that has guided thousands of plants throughout the country to the selection of Johns-Manville Insulations.

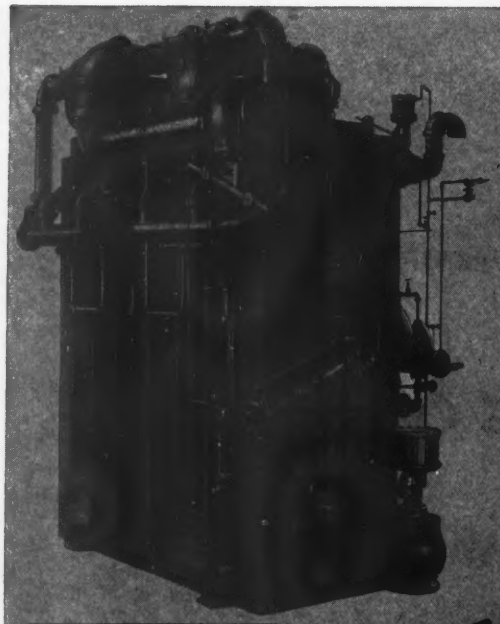
Equally pertinent to you is the fact that Johns-Manville makes insulating materials specifically designed to offer the best possible investment returns on *any* and *every* type of heated or refrigerated equipment in *your* plant.

* * *

With some forty different kinds of insulation in every desired thickness—Johns-Manville has no sales preferences of its own. And is just as concerned with furnishing the particular insulating materials that promise the greatest assurance of full and continued cash dividends as you are in getting them. Johns-Manville, 22 East 40th Street, New York City.

Johns-Manville **INDUSTRIAL INSULATIONS**

An insulating material for every temperature... for every service condition



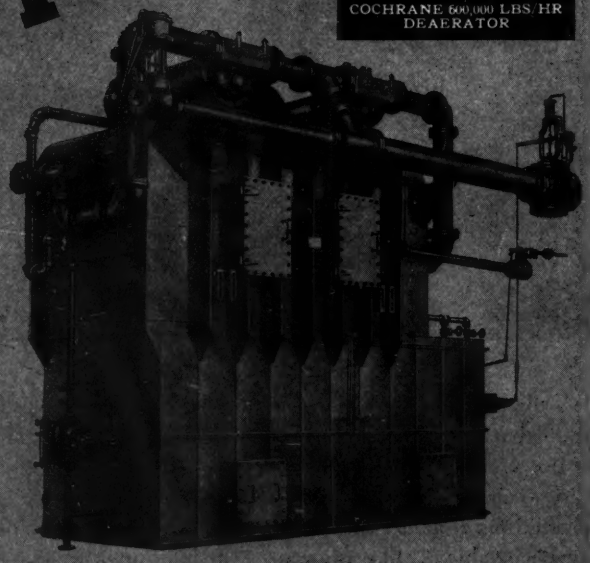
COCHRANE 260,000 LBS/HR DEAERATOR

Steadily increasing plant loads . . . extensions to existing power generating facilities . . . require greater protection for expensive high pressure boiler units. Power plant designers and engineers look to Cochrane for feed water conditioning equipment that keeps pace with current trends toward higher steam pressures and temperatures.

As one proof of Cochrane's preeminence in the field of deaerating equipment, consider the case of the installation shown to the left. It is in the plant of a prominent central station where increasing demands required five successive installations of deaerating equipment. All five units are Cochrane-designed and Cochrane-made. The first unit was installed in 1922; the fifth unit (illustrated), installed in 1936, handles feed water at the maximum rate required by five new 260,000 Lb/Hr boilers.

Keeping Pace with Higher Pressures

COCHRANE 600,000 LBS/HR DEAERATOR



In another instance, where a "topping" extension involving an 860 lb. boiler supplied with deaerated water from a 600,000 Lb/Hr Cochrane Deaerator, rapidly increasing demands have occurred since the installation. Loads as high as 800,000 Lb/Hr have been required of this deaerator. Although 33% in excess of its rated capacity, this unit is consistently supplying deaerated water with zero oxygen.

Such performances prove justification for designers and engineers having confidence that Cochrane can provide the right type of feed water conditioning equipment for perfect protection.

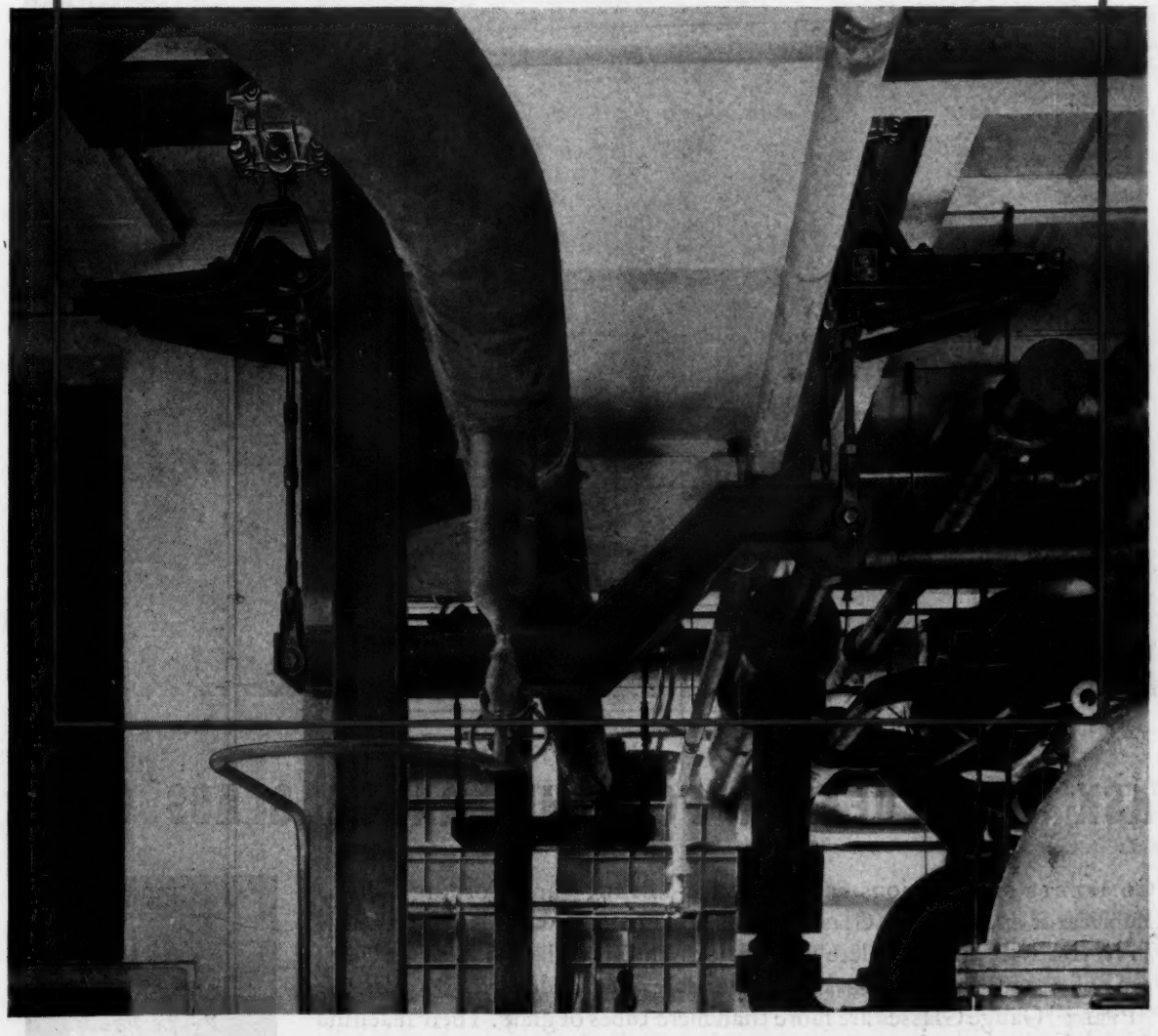
WRITE FOR BULLETINS ON THE LATEST DESIGNS IN DEAERATING HEATERS AND HOT PROCESS SOFTENERS

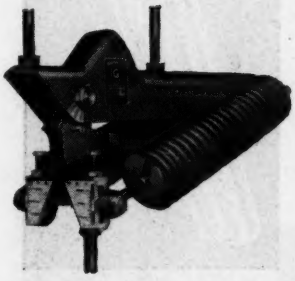
COCHRANE CORPORATION • 3123 N. 17th STREET • PHILADELPHIA, PA.

COCHRANE

WATER SOFTENERS • DEAERATING HEATERS • DEAERATORS • BLOW-OFF EQUIPMENT • VALVES • FLOW METERS

"The Installation is as good as its Hangers"





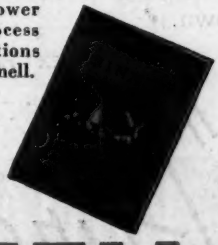
No matter how much engineering genius is involved in the development of a prefabricated piping installation, that installation is only "as good as its hangers" — it must be free to float — to expand and contract in any direction. . . .

That is why the same engineering skill and experience that brought Grinnell Prefabrication into the lead built equal efficiency into Grinnell Genspring Constant Support Pipe Hanger.

The Genspring Hanger affords constant, adequate support throughout the entire range of the pipe's vertical and horizontal movement. Thus it adds another reason to the many that prompt leading users of prefabricated piping to say "Give the plans to Grinnell!" Grinnell Company, Inc., Executive Offices, Providence, R. I. Branch offices in principal cities.

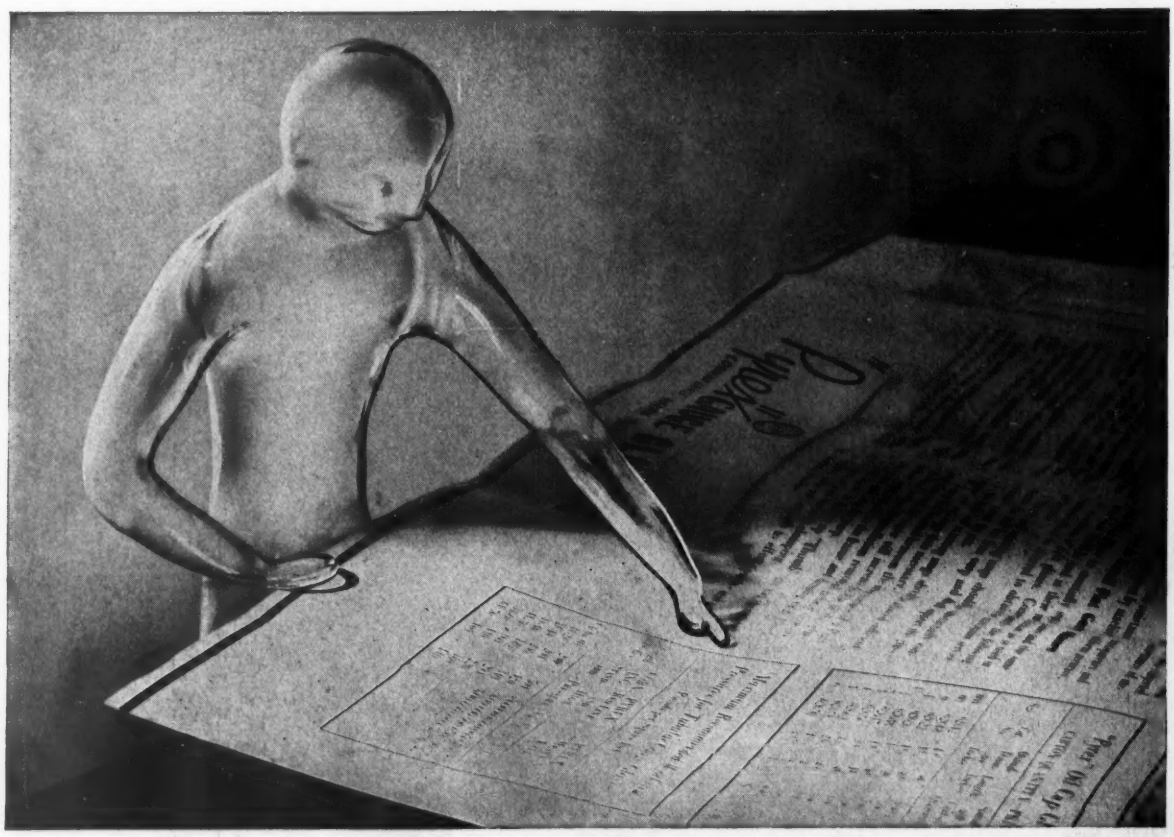
PREFABRICATION IN PICTURES

Send for this booklet — you'll find many worthwhile illustrations of complicated and routine power and process installations by Grinnell.



PREFABRICATION AND FITTINGS BY GRINNELL

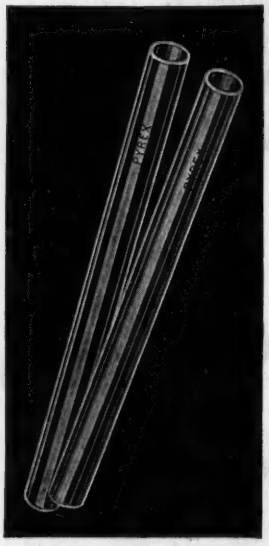
WHENEVER PIPING IS INVOLVED



ASK YOUR DEALER FOR THIS GAUGE GLASS DATA

COMPLETE specifications and prices for "PYREX" and Corning Gauge, Lubricator and Oil Cup Glasses are given in the new folder just issued. In it you will find complete descriptions and installation data on every type of gauge glass, for work at all pressures and under every condition. "PYREX" Gauge Glasses are more than mere tubes of glass. Their machine drawn accuracy, resistance to sudden temperature changes, mechanical strength, chemical stability and transparency insure a long life with the utmost in economy and satisfaction.

Ask your dealer for a copy of the new "PYREX" Gauge Glass Bulletin. If he does not have one, write, giving his name and address as well as your own.



"PYREX" is a registered trademark and indicates manufacture by Corning Glass Works.

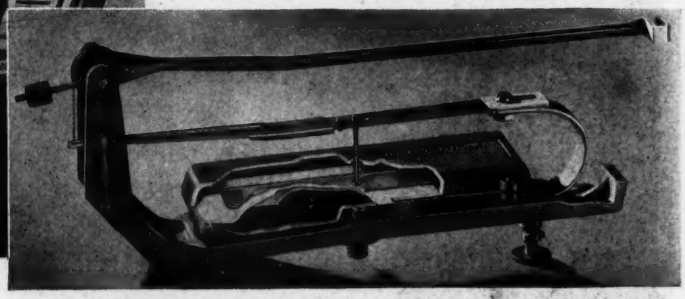
"Pyrex" GAUGE GLASSES

CORNING GLASS WORKS, CORNING, N. Y.

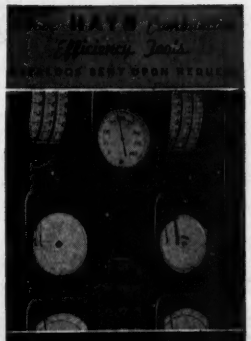
CORNING *means* Research in Glass

MAINTAIN *the Proper* DRAFT

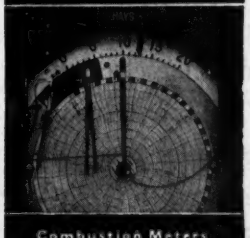
. . . AND YOU HAVE TAKEN THE FIRST AND MOST IMPORTANT STEP TOWARD ECONOMICAL BOILER ROOM OPERATION



The famous Hays slack leather diaphragm unit that revolutionized draft gage construction. Compact, simple, long-lived, highly sensitive, accurate. Requires no leveling.



Complete Instrumentation and Automatic Combustion Control



Combustion Meters

Portable Combustion Testing Instruments

HAYS originated the dry or diaphragm type of Draft Gage. Prior to the introduction of the revolutionary Hays slack-leather diaphragm mechanism the draft gage was a bent glass tube or a strange conglomeration of inverted bells, counterweights, oil seals and involved linkages.

The Hays diaphragm mechanism sprang into instant favor. Its simplicity, compactness and accuracy made such an appeal to industry in general that it was soon complimented by imitations and still is. But only Hays has available the results of thousands of field tests and the technical experience accumulated during years of research and manufacturing.

Hays Draft Gages are offered in a wide variety of types, suitable for every draft measuring requirement. A recording type is also available. Write today for late Catalog just off the press. Use the coupon below.

Dept. 102 MAIL THIS COUPON

☐ Send late Catalog on Hays Draft Gages ☐ Send Catalog on Combustion Meters

Individual_____

Title_____ Firm_____

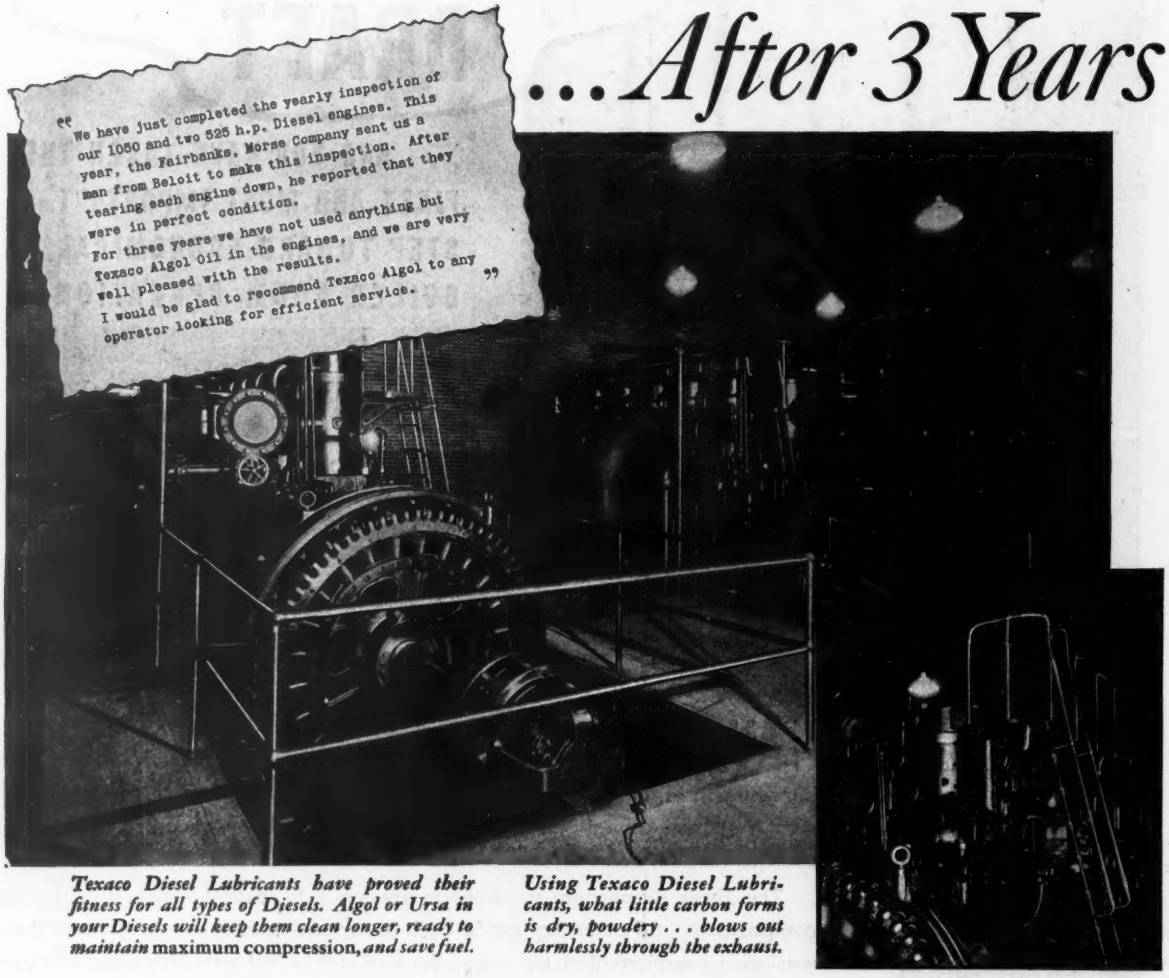
Street & No._____ Town & State_____

THE HAYS CORPORATION

SINCE 1901 COMBUSTION INSTRUMENTS AND CONTROL

MICHIGAN CITY, INDIANA, U.S.A.

"PERFECT" ...After 3 Years


"We have just completed the yearly inspection of our 1050 and two 525 h.p. Diesel engines. This year, the Fairbanks, Morse Company sent us a man from Beloit to make this inspection. After tearing each engine down, he reported that they were in perfect condition.
For three years we have not used anything but Texaco Algol Oil in the engines, and we are very well pleased with the results.
I would be glad to recommend Texaco Algol to any operator looking for efficient service."

Texaco Diesel Lubricants have proved their fitness for all types of Diesels. Algol or Ursa in your Diesels will keep them clean longer, ready to maintain maximum compression, *and save fuel.*

Using Texaco Diesel Lubricants, what little carbon forms is dry, powdery . . . blows out harmlessly through the exhaust.

LETTERS LIKE THIS—from operators of both large and small plants—show that these men have proved to *themselves* what Texaco Diesel Lubricants do in actual service. As a direct result of such performance, *more Diesel h.p. in the U.S. is lubricated with Texaco than with any other brand.*

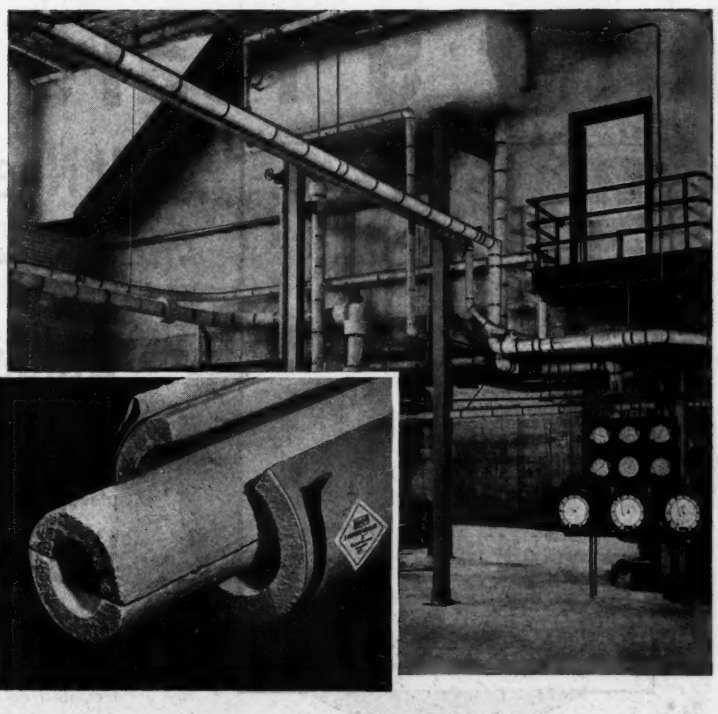
Trained lubrication engineers are available for consultation on the selection and application of Texaco Diesel Lubricants. Prompt deliveries assured through 2070 warehouse plants throughout the United States.

The Texas Company, 135 East 42nd Street, New York City.

TEXACO

TEXACO *LUBRICANTS FOR ALL TYPES OF DIESELS*

Heat insulation that pays permanent dividends



K&M "FEATHERWEIGHT" 85% MAGNESIA

You start to save money the moment you install 85% Magnesia insulation. And it is a saving that never ends. For not only is 85% Magnesia one of the most efficient heat insulators ever developed . . . its durability is almost unique.

Floods, water leakage and steam do not affect it. It has been submerged in sunken ships, salvaged, dried out and re-applied with no loss in its high efficiency. For temperatures up to 600°F., no other material can offer more enduring economy.

K & M "Featherweight" 85% Magnesia, like all products of this company, has behind it more that 60 years' experience in the development and large-scale production of asbestos and magnesia products. The K & M line is complete, and specialized for the needs of each plant.

Send for information

"Featherweight" 85% Magnesia Pipe Insulation, Blocks and Lagging • Air Cell Insulations in sections and blocks • Asbestos Pipe Insulation in sections • Asbestos Insulation in sheets and blocks • Asbestos Insulating Cements • Asbestos Packings: rope, cord and sheet • Asbestos Gaskets, Gasket Tapes and Cloth • Friction Materials.

Underline the products on which you want full information and mail this coupon today.

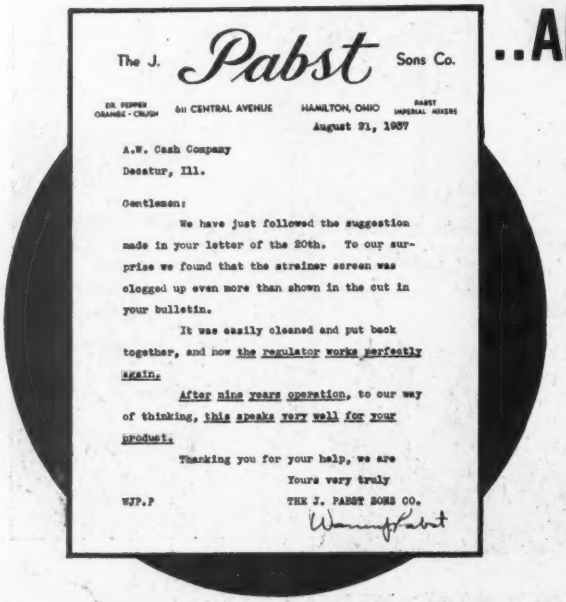
Name_____

Name of Firm_____

Address_____ 8-11

KEASBEY & MATTISON COMPANY AMBLER, PENNA.

After 9 Years Service



The J. Pabst Sons Co.

DR. PEPPER ORANGE-CRUSH — 611 CENTRAL AVENUE — HAMILTON, OHIO — PABST IMPERIAL BEERS

August 21, 1937

A.W. Cash Company
Decatur, Ill.

Gentlemen:

We have just followed the suggestion made in your letter of the 20th. To our surprise we found that the strainer screen was clogged up even more than shown in the cut in your bulletin.

It was easily cleaned and put back together, and now the regulator works perfectly again.

After nine years operation, to our way of thinking, this speaks very well for your product.

Thanking you for your help, we are

Yours very truly

WJP.P — THE J. PABST SONS CO.

Wm. J. Pabst

..All It Needed Was Cleaning!

The letter tells the story . . . and it's typical of the experience of Cash Standard valve users. After 9 years continuous use, this Class D valve simply needed cleaning.

Quickly and Easily Done

No removing the valve or dismantling it. No readjustment or testing. The working unit was simply removed by one of the plant's own men, the screen cleaned, and then replaced.

Worked Perfectly Again

There's proof of durability, simplicity, and low maintenance cost! Cash Standard Class D Pressure Reducing Valve avoids binding and sticking. Simplicity, strength and trouble-free service are apparent from this cut-out view.

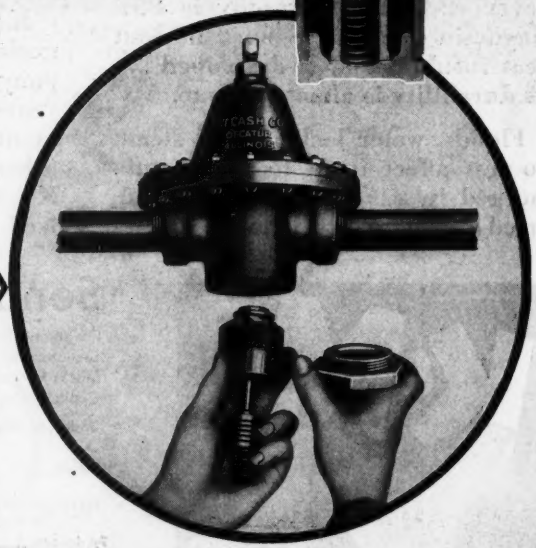
CASH STANDARD

CLASS D PRESSURE REDUCING VALVE

A Cure for "IDLE MEN"

Long delays—production at a standstill while valves are removed, repaired, and replaced—or sent back to the manufacturer for repair—you avoid all this with the installation of the Cash Standard Class D Valve with

CARTRIDGE TYPE WORKING UNIT



Unscrew the bottom closing cap, remove the complete assembly . . . cylinder, piston and all. Replace it as simply. Any man can do it—saving hours of time when time counts. By replacing with an inexpensive renewal unit, if necessary, the valve is good as new. There's a lot more to say about this Class D valve. Write and we'll send the complete bulletin.

A. W. CASH COMPANY, Decatur, Illinois

ENGINEERED *as a Unit*

COMPLETE EQUIPMENT
UNDIVIDED RESPONSIBILITY

In the above 5000 kw installation the turbine was designed for 825 lb. pressure and 825° F temperature—side outlet exhaust—generator air coolers built into the generator—condenser above turbine floor—air removal equipment, and feedwater heaters between the condenser and turbine—boiler feed pumps above the operating floor—tilting type generator for removal of generator rotor over the turbine.

A typical example of Allis-Chalmers engineering to meet space limitations above and below the operating floor—to permit using an existing engine foundation—to give high overall efficiency, extreme accessibility, minimum space requirements.

826

You may not need a 'PACKAGE TYPE' turbo generator unit—but you can still take advantage of Allis-Chalmers engineering on the complete generating unit.

EQUIPMENT ENGINEERS TO INDUSTRY

ALLIS-CHALMERS

MILWAUKEE WISCONSIN

Three Steps to Better Power Plant Performance

The American Blower Induced Draft Fan

The first step in planning a modern power plant, or modernizing an old one, is to select an induced draft fan that is adaptable to the more advantageous motor speeds required for modern high pressure duty. The fact that the American Blower Induced Draft Fan operates at a lower tip speed than any other type of fan and at a better r.p.m. . . . that it has a large, low-loss streamlined inlet . . . low-loss streamlined inlet boxes . . . and a flowing fan housing . . . insures its adaptability to the motor speeds which are preferred in the most modern of power plants. That is why more and more engineers are insisting on American Blower Induced Draft Fans.

Hydraulic Coupling for Variable Speed control

The second step is the selection of Hydraulic Couplings for variable speed fan control. The Hydraulic Coupling is an ingenious device that uses oil as a medium to transmit power in varying quantities, and makes it possible to combine the electrical advantages of constant speed induction on synchronous motor drive with the operating advantages of variable speed drive. It gives a wide range of control, infinite number of speeds, absolute stability at all speeds, rapid response to changes in boiler load, shock-proof starting, and permits the fan to operate at the correct speed to produce the required volume and pressure.

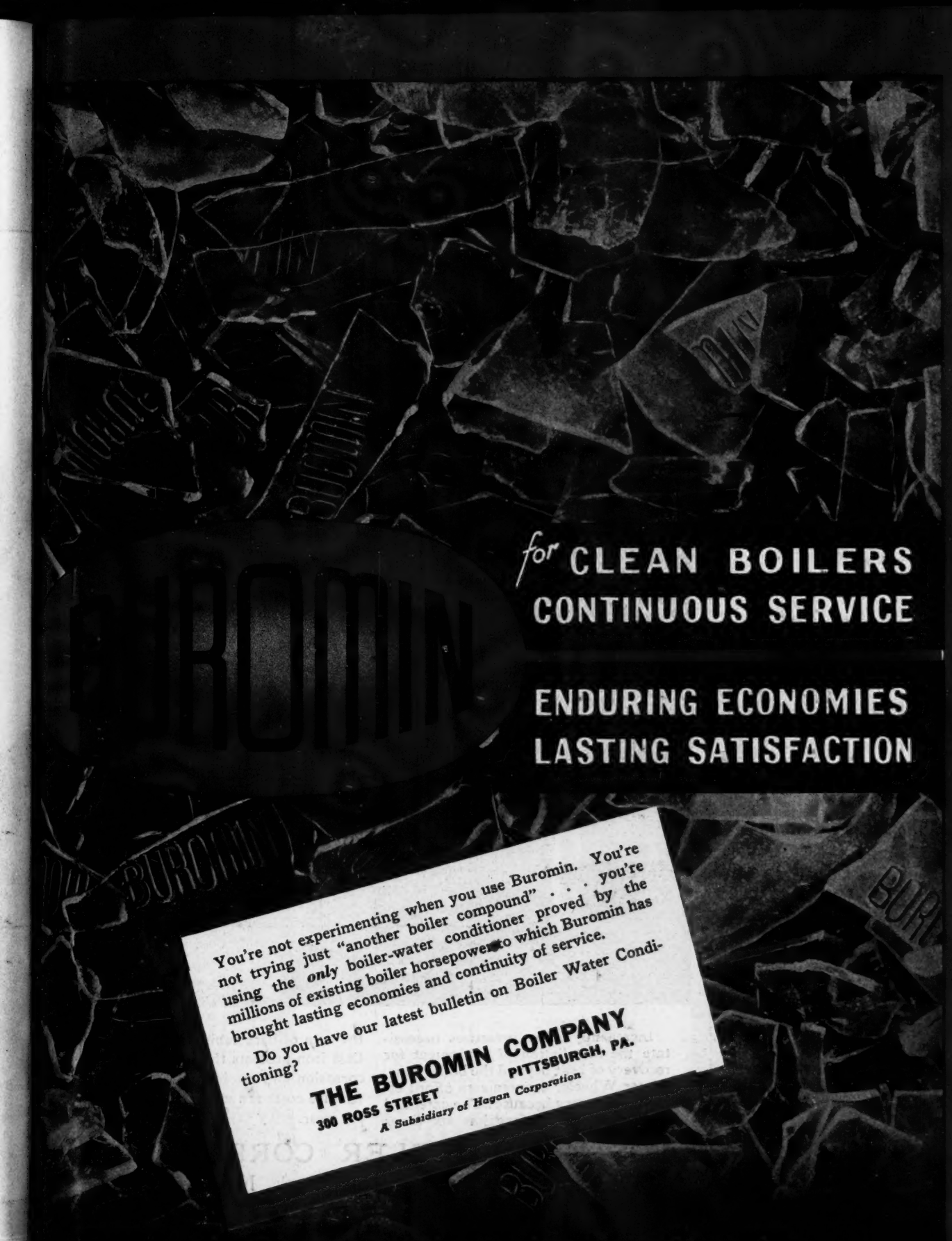
The American Blower Type ST Dust Collector

The third step is the application of American Blower Dust Collectors to minimize the fly ash nuisance. The American Blower Type ST Collector (shown on left) is the most practical type for installation in modern power plants. It has no moving parts, is of the dry type and makes possible installations in less space than that required by many types of collectors. It is ideal for both present power plants and new ones due to the fact that it does not require as much structural strength in the building. . . . For data on American Blower Dust Collectors, Hydraulic Couplings and Induced Draft Fans —telephone the nearest American Blower Branch Office.

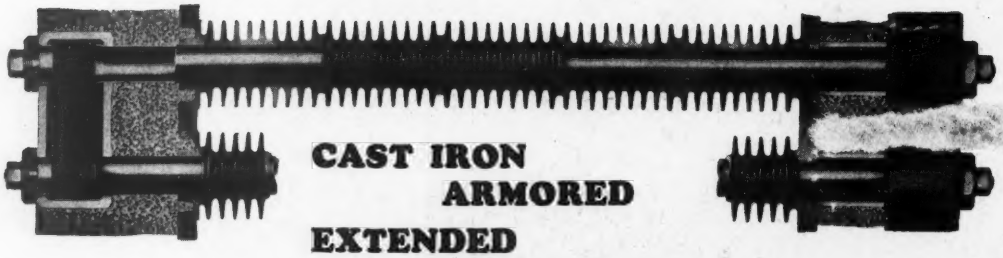
AMERICAN BLOWER

Division of American Radiator and Standard Sanitary Corp.

6000 Russell St., Detroit, Mich. Canadian Sirocco Co. Ltd., Windsor, Ont.


for CLEAN BOILERS
CONTINUOUS SERVICE
ENDURING ECONOMIES
LASTING SATISFACTION
You're not experimenting when you use Buromin. You're not trying just "another boiler compound" . . . you're using the *only* boiler-water conditioner proved by the millions of existing boiler horsepower to which Buromin has brought lasting economies and continuity of service.
Do you have our latest bulletin on Boiler Water Conditioning?
THE BUROMIN COMPANY
300 ROSS STREET PITTSBURGH, PA.
A Subsidiary of Hagan Corporation

Buromin, a glass-like, quickly soluble, pure chemical of uniform quality, is not an unknown compound, but a healthful treatment for any boiler.



CAST IRON
ARMORED
EXTENDED
SURFACE

ECONOMIZERS

8640 sq. ft. central station economizer serving an 1150 h.p. boiler. 140,000 lb. of feedwater per hour are heated to 360 deg. F.

Increasing boiler pressures necessitate the installation of equipment for recovery of heat beyond the boiler zone. Foster Wheeler economizers afford effective recovery because: The extended heat absorbing surface has six times the area of bare tubing per lineal foot. Cast iron protects the steel tubes from corrosion and erosion. Average maintenance costs are well under 1 per cent per year.

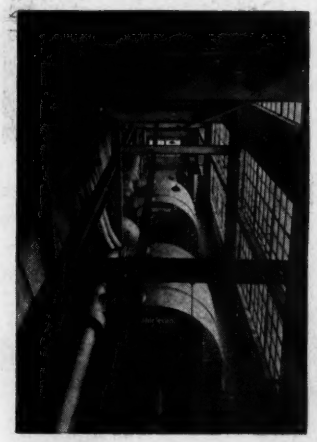
FOSTER WHEELER CORPORATION
165 Broadway, New York, N. Y.

FOSTER WHEELER

World's Outstanding POWER STATIONS

are equipped with Sturtevant Mechanical Draft Fans!

PORT WASHINGTON STATION—MILWAUKEE ELECTRIC RAILWAY & LIGHT CO.
—ONE OF THE LEADING PLANTS OF THE UNITED STATES



At Port Washington Station:—

(1) Sturtevant Draft Fans handle almost 2½ million pounds of gas per hour.

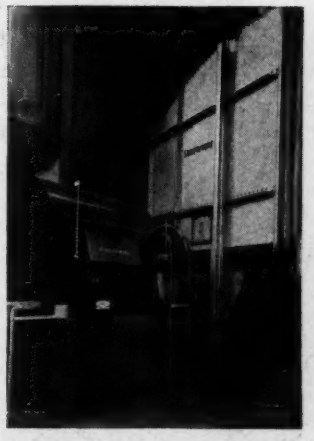
(2) Forced Draft Fans operate at peripheral speed of 3 miles per minute, and are conservatively understressed even at this high speed.

(3) Induced Draft Fans handle flue gas at a temperature of 370 Dgs. F., against static discharge pressure of 11.5 inches water gauge. Designed to reduce erosive wear to a minimum.

B. F. STURTEVANT CO., Hyde Park, Boston, Mass.
Branch Offices in 40 Other Cities
B. F. Sturtevant Company of Canada, Limited—Galt, Toronto, Montreal

Sturtevant
REG. U. S. PAT. OFF.

Puts Air to Work



DRAFT FANS · TURBINES · GEARS · ECONOMIZERS · AIR HEATERS

"We Have Replaced $2000.00 Worth of Old Type Traps with YARWAYS"

"We Found It Cheaper Than Making Repairs"

(Reports Refrigerator Mfr.)

How to end Steam Trap troubles? Ask Yarway Trap users. They will tell you about their:

QUICKER HEATING . . . hours saved in starting up.

GREATER SUSTAINED HEATING EFFICIENCY . . . keeping machines, equipment and heating systems hotter, all the time.

LOW MAINTENANCE . . . where other type traps have required frequent renewal of parts, Yarways stand up.

FUEL SAVINGS . . . through proper draining and elimination of air-binding and through less radiation loss due to the small size of Yarway Traps.

EASE OF INSTALLATION . . . requiring no supports, less space. Same trap without change is applicable to almost all requirements, up to 400 lbs. pressure. (All-steel, stainless-steel-trimmed traps for pressures up to 600 lbs.)

LOW PRICE . . . often, as the user above testifies, it costs less to install new Yarways than to bother with repairing other type traps.

Ask Yarway Trap users, or better yet—get some Yarway Traps, try them out in your own plant, write your own testimonial. Thousands of Yarway Impulse Traps have been bought in this way. It's the way we would rather win many more thousands of satisfied users.

A nearby mill supply house handles them (more than 100 leading distributors in principal cities). Catalog T-1722 sent on request.

YARNALL-WARING COMPANY, 114 Mermaid Ave., Phila.

YARWAY IMPULSE STEAM TRAP

Choosing Materials for Edward Valves—No. 5 of a Series

TIRED WHEN ITS HOT!

Here, in Edward physical laboratory, properties of steel are found with microscopic accuracy. From right to left: Vickers hardness testing machine. Then, Amsler tensile testing machine, consisting of: oil pump, pendulum dynamometer, testing machine itself, "pulsator" for "tiredness" tests at fluctuating loads under service temperatures, and Amsler-Martens extensometer (on tripod) for ultra-precision elongation measurement.

STEEL gets tired when it's hot. And we don't mean weather. It is the heat of operation—steam, oil, or what have you—that causes some steels to weaken faster than others. Steel stands up well, or not so well, in proportion to inherent qualities which are isolated, identified, and appraised by Edward technicians.

Edward valves are now being sold in far greater number than ever before—and Edward has always specialized in valves for severe service—for use under top heat and pressure. So Edward, more than ever, strives to use only materials that are exactly right.

Equipment in the Edward laboratories continues to stress the significance of tests over the entire temperature range at which the valves are to work.

Have you Edward material specifications guide No. A-10? It's yours for the asking.

• • •

THE EDWARD VALVE & MFG. CO., INC.
EAST CHICAGO INDIANA

Edward Valves

Stop • Check • Non-return • Blow-off • Feed Line • Relief • Bleeder Line • etc

Machinery, Equipment and Supplies Used in The Generation, Transmission and Utilization of Power

Air Compressors
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Combustion Engrg. Co., Inc.
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American Blower Corp.

Arches, Boiler & Combustion
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Ash Handling Systems
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Link Belt Co.
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Blowers, Fan and Furnace
De Laval Steam Turb. Co.
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Blowers Forced Draft, Portable, Pressure & Coal
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Blowers, Tube
Bayer Company

Blowers, Turbine
Elliott Co.
Moore Steam Turb. Corp.
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Elgin Softener Corp.
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Permutit Co.

Boiler Feeders
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Norton Co.
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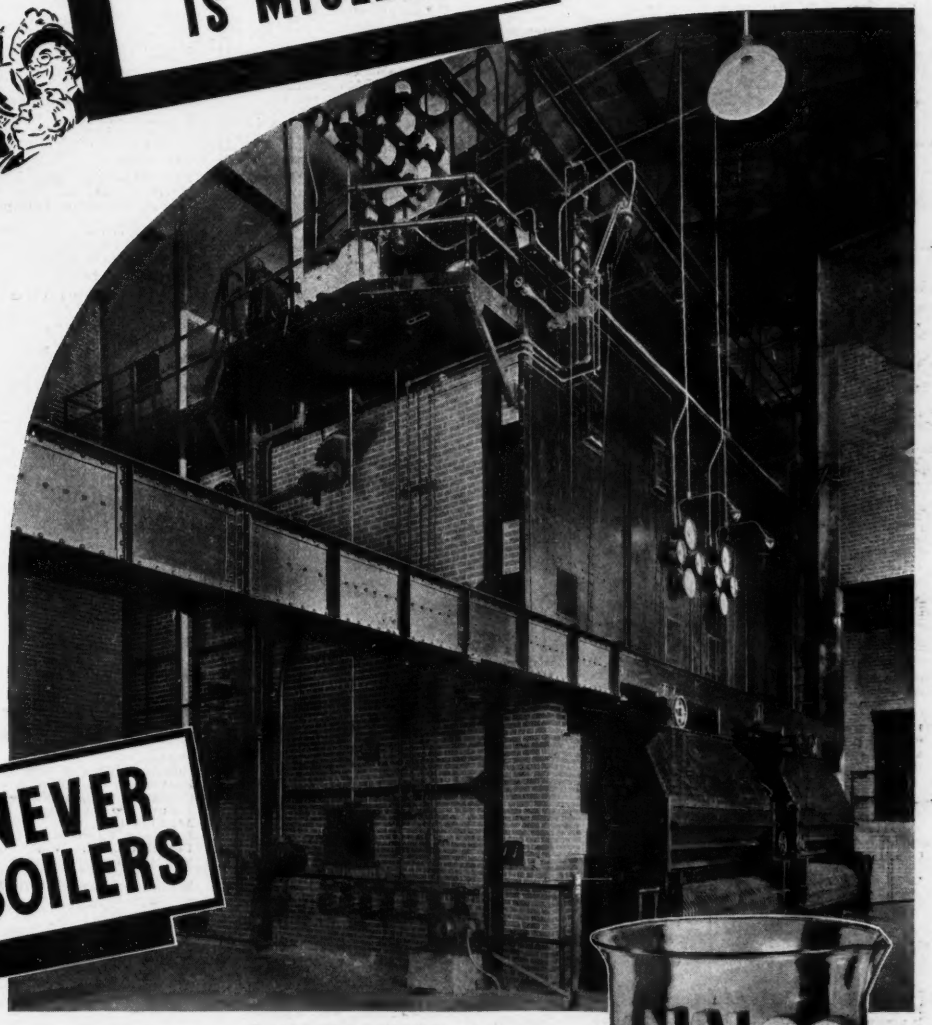

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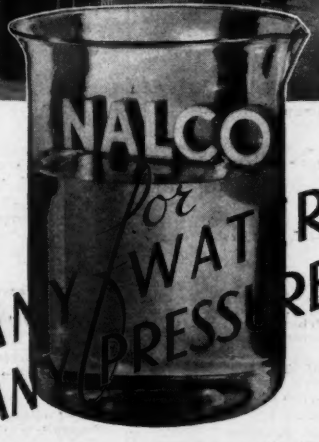

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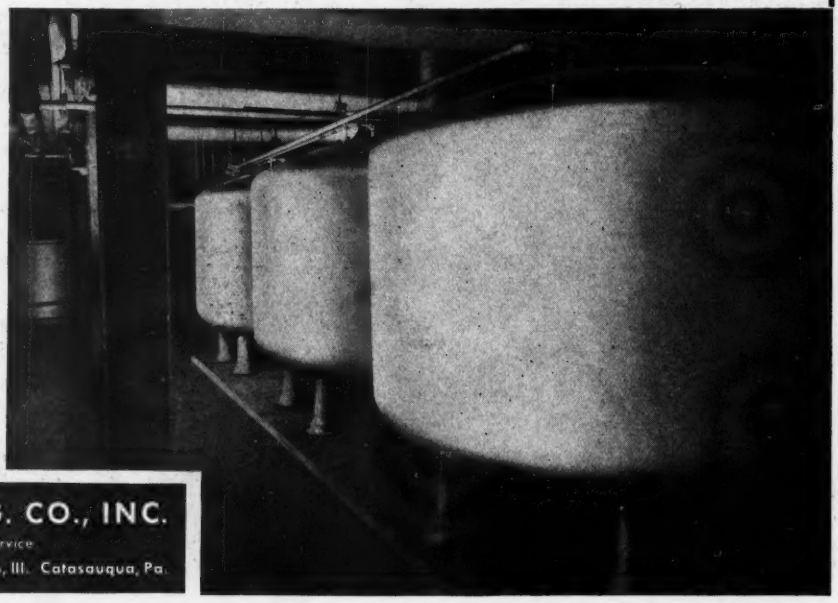

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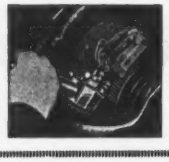

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Jenkins Fig. 976 has the new Jenkins "Armor-Seat"... made of Jenkins JX500 special alloy steel, exceeding 500 Brinell hardness. It is practically impervious to wear, wire drawing and other valve destroyers. It cannot be cut by throttled steam or harmed by substances which get into pipe lines, such as pipe chips and boiler scale.

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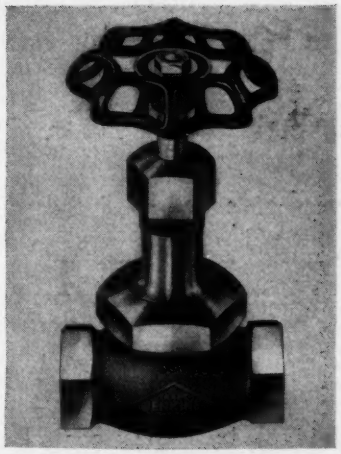

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Nothing that would conceivably get into the valve could scratch Jenkins JX500 special alloy steel seat. Compare 500 Brinell with the hardness of some substances which do get into pipe lines... boiler scale, pipe chips, welding beads, rust tubercles, iron oxides... even with other familiar objects that are softer, such as a common nail which is under 200 Brinell hardness.

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Of course there are problems. If there were none, the power plant engineer or executive would be out of a job. Operation would become more routine. There would be no challenge to initiative or ingenuity. Actually the plant executive needs all the new ideas and information he can get to help solve problems and improve methods.

Modern high pressures and temperatures are hard on valves. Use of special alloy steel seats for small valves should help to solve plant problems in handling 1500-lb., 950-deg. steam.

In pipe installations, how to save heat and how to remove condensation are vital, sometimes troublesome, problems. In the Engineer's Library section are noted catalogs which will aid in solving them. Magnesia and Asbestos; Sheet, Block and Pipe Insulations; Steam Hookups for Traps are cases in point. In the matter of condensate handling, Automatic Boiler Service Units are of interest and, allied to this is the question of Water Softeners to give satisfactory make up water.

Moving levers of dampers, valves or rheostats in remote places calls for reliability and durability of the motor. The new Evenaction motor, with regulatable stroke, adjustable power and operated by manual control, pneumatic controller or electro-pneumatic switch is an answer to the problem.

For low pressures, measurement of the absolute pressure is frequently desirable, especially for distillation, evaporation and condensation equipment. For such use the new Taylor absolute pressure element with non-corrosible bronze bellows gives indication or record of absolute pressure or may be utilized for controlling absolute pressure at any point.

Clinkers, what a job they make for the boiler room force. Prevention is better than fighting them after they are formed. So, Mr. Darnell's suggestions are to the point.

Close quarters in the boiler room and need for all possible clearance in front of the boiler may be taken care of by the new bin-fed stoker put out by several stoker manufacturers.

To get clean air is a difficult problem, as most of the extremely fine dust is not removed in washing. Electricity comes to the rescue as shown in the article on the precipitator developed by Westinghouse laboratories.

Reducing 110 v. to 6 v. and changing it to d.c. is the stunt performed by a new device the Rectiformer, which heretofore has called for separate transformer and rectifier. It should be useful for many purposes.

Why not study the aids that manufacturers offer to the solution of your plant operation problems? If you want a catalog or information regarding equipment let us know and we will gladly get it for you from the manufacturer. Write to Reader Service, Power Plant Engineering.

5 TIMES A MINUTE

300 Times an Hour

OPEN, shut—open, shut. Ceaselessly, valves are opened and shut in a special "torture machine" at the Crane laboratories. Five times a minute . . . 300 times an hour . . . 2,400 times every eight-hour shift, until the stem gives up its life and the "post-mortem" adds to the vast body of Crane knowledge of valves.

Engineers tabulate the results and study the thread profiles and thread clearances of the valves when finally they are worn out. From this comes definite information showing how to make good valves better . . . and better valves the best for their type of service.

Crane has tested to destruction thousands of valves, seeking information with which to build still better valves. Crane meets the challenge of "new" valve problems with solutions based on 82 years of valve and piping experience. Look in your new Crane No. 52 Catalog for the details regarding 38,000 items, tested in the laboratory and proved on the job. Use it whenever you need valves, fittings, pipe or accessories. CranEquip for satisfaction.

CRANE

CRANE CO., GENERAL OFFICES: 836 S. MICHIGAN AVENUE, CHICAGO, ILL

Branches and Sales Offices in One Hundred and Sixty Cities

VALVES, FITTINGS, FABRICATED PIPE, PUMPS, PLUMBING AND HEATING MATERIAL

plied in the next few days.

STICKING TO QUALITY SIMPLE SAFEGUARD, SAYS ENGINEER

NEW YORK CITY, Nov. 10—"The power plant engineer who sticks to a policy of buying only quality products, whether large or small items, is the man who operates at lowest costs and with least trouble," said a power plant engineer here today.

"The original cost of a small valve is so little, or the leakage from one small valve may seem so small that it is easy to overlook the large losses over a year that come from replacing many small valves or having a large number of small leaks," he continued.

Crane has always recognized the importance of doing small things well. The testing of small valves to destruction in a machine that opens and shuts them continuously under service loads is one illustration of Crane care in providing highest quality at low cost in small valves.

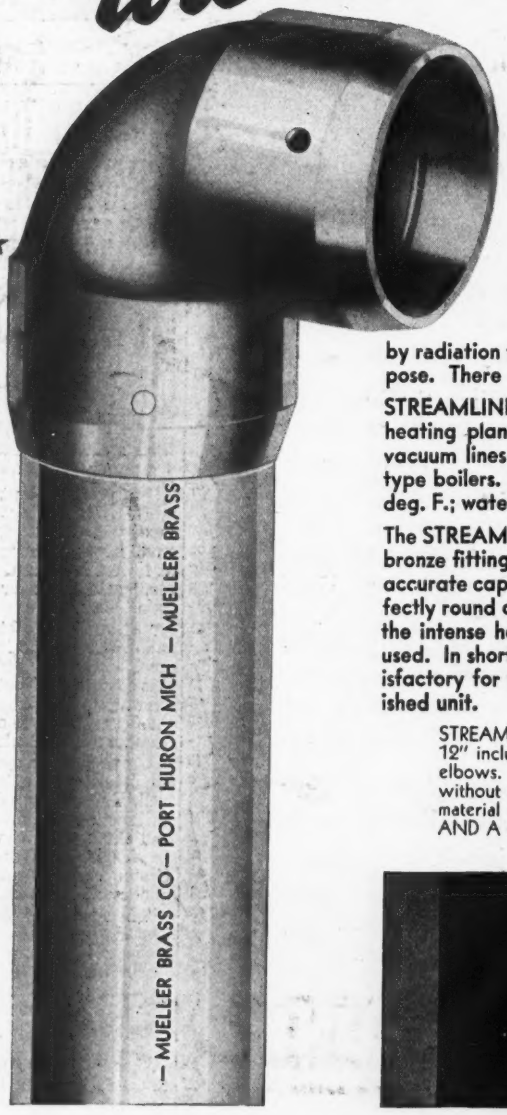
The results of these tests are reflected in better threads, better stems, better body and seat materials. When next you need small valves, specify Crane. Check up, for example, on the number of spots where the Crane No. 7 line of valves can serve you. Sizes from ⅛ to 3 inches, globe and angle, screwed or flanged, Slip-On Disc Holder for quick and easy replacement, discs of various types for various services. See page 16 of your Crane No. 52 Catalog for details. CranEquip for piping satisfaction.

STREAMLINE

TRADE MARK REG. U. S. PAT. OFFICE

COPPER PIPE AND FITTINGS

are not expensive



THE installed cost of STREAMLINE Copper Pipe and Solder Fittings is very little, if any, higher than rustable materials; yet it has outstanding advantages for countless uses in piping jobs where temperature and pressure are not excessive—and as a rule, its first cost is its final one. It cannot rust. Its ultra-smooth interior finish offers no anchorage point for the accumulation of scale or other foreign matter. It is easily installed in the closest quarters. It is a space economizer.

The transmission of heat through Copper Pipe is effected more rapidly and with less heat loss by radiation than through any other piping materials used for the purpose. There are savings in insulating materials too.

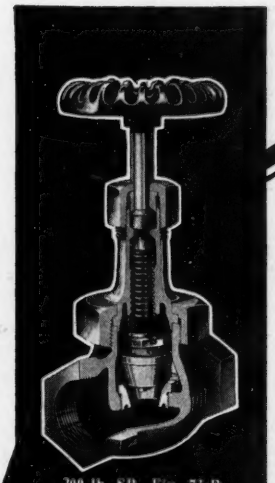
STREAMLINE Copper Pipe and Fittings are widely used in power and heating plants for steam, hot and cold water, compressed air and vacuum lines; also brine lines in refrigeration systems and gas-fired type boilers. They handle steam (saturated) up to 80 lb. gage or 325 deg. F.; water, etc., up to 400 lb. working pressure.

The STREAMLINE Fitting is the original solder type fitting. It is a cast bronze fitting—rigid and strong. The pipe openings are machined to accurate capillary fit for the pipe—and more than that, they stay perfectly round and retain their proper tolerance even when subjected to the intense heat required when the higher melting point solders are used. In short, they make a more positive, workmanlike job, more satisfactory for you to use, and eminently more satisfactory for the finished unit.

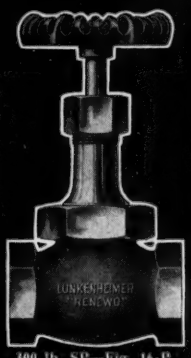
STREAMLINE Solder Fittings are manufactured in sizes from 1/4" to 12" inclusive, and in a complete range of reductions in tees and elbows. You connect directly to the smaller or larger pipe lines without the use of adapters with their additional expense, both for material and labor. A BETTER JOB—A LESS EXPENSIVE JOB—AND A MORE WORKMANLIKE JOB.

STREAMLINE
PIPE AND FITTINGS DIVISION
MUELLER BRASS CO.
PORT HURON, MICHIGAN

A COMPLETE LINE of Plug Type Seat and Disc Valves



200 lb. SP—Fig. 73-P
Bronze "Renewo"



300 lb. SP—Fig. 16-P
Bronze "Renewo"

"NS5" Alloy
Plug Type
Seat and Disc

Lunkenheimer offers a complete line of valves with "NS5" Alloy plug type seats and discs in bronze, bronze mounted and all-iron patterns and for 150 to 300 lb. SP—225 to 600 lb. GLP.

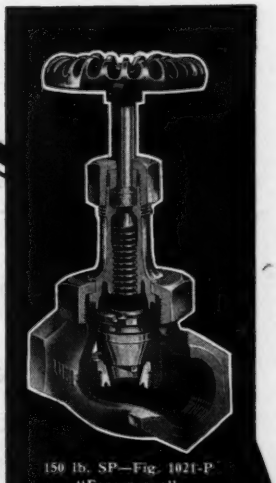
The various patterns provide an economical selection of the proper valves for specific pressures—for general service and also for the more severe services such as throttling, drip, drain, water column blow down etc.

"NS5" Alloy is of uniformly great hardness and retains its hardness at high temperatures; it is free from galling, seizing and corrosion. The wide seat faces retard wire drawing. These are qualities which insure the longer valve life necessary for lower valve costs.

Place a few of these valves in service in your plant and let them prove themselves under actual operating conditions. Your Lunkenheimer distributor carries them in stock.

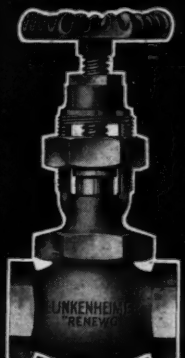
THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI, OHIO, U.S.A.
NEW YORK CHICAGO
BOSTON PHILADELPHIA
EXPORT DEPT. 318-322 HUDSON ST., NEW YORK

Write for your copy of the new circular No. 559 or ask your distributor.



150 lb. SP—Fig. 1021-P
"Ferrenewo"

150 lb. SP Fig. 1887-P
All-Iron "Ferrenewo"



300 lb. SP—Fig. 1690-P
Screwed Yoke
Bronze "Renewo"

Buy QUALITY—Buy LUNKENHEIMER

102-87A-44

PAY $ LESS

FOR THE FINEST UNION MONEY CAN BUY

It pays to economize with Darts. For Darts have two bronze seats, first precision machined then ground to a full bearing true ball joint.

Take down a Dart. Reinstall it time and again. It's tight every time. Moreover, Dart bodies and nut are extra-heavy, air-refined malleable iron—built to resist pipe strains, wrench abuse, repeated use.

It takes extra manufacturing operations to give Darts this extra performance—to make a joint that prevents breakage, stretch, thread distortion, that permits no leakage, no loss of time. And you get more out of Darts in service—for less money.

Next time you change piping change to Darts. Want us to send you one to try, at our expense? No obligation. Tell us what size you use most.

E. M. DART DART UNIONS MFG. CO.

PROVIDENCE, RHODE ISLAND

Sales Agents: The Fairbanks Company, New York, and all branches

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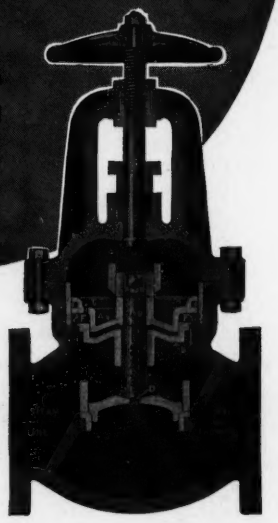
"Automatic Testing"

one of the important safety features of G-A Automatic Non-Return Valves



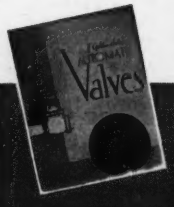
FOLLOWING are features of Golden-Anderson Automatic Double Cushioned Non Return Valves which help safeguard the lives of your men, your property and your plant production:

1. Automatic Testing Feature, available only in Golden-Anderson Valves, permits valve testing under pressure from boiler room floor.
2. They prevent shutdowns due to reversal of steam flow.
3. Instantly close and isolate a boiler when a tank ruptures.
4. Automatically cut a boiler into line.
5. Prevent backflow of steam into a cold boiler.

"4601" of these Golden-Anderson Valves are now being used by large iron and steel companies who cannot afford to take chances on steam line breaks. Write for descriptive catalog.

GOLDEN-ANDERSON VALVE SPECIALTY CO.

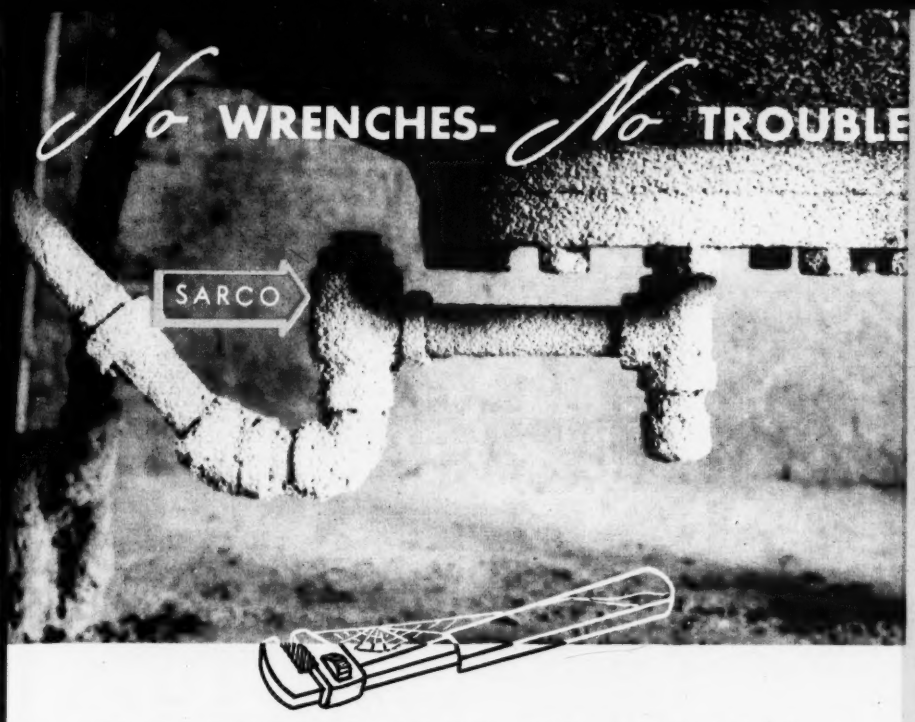
1316 Fulton Bldg., Pittsburgh, Pa.



Send for New Catalog

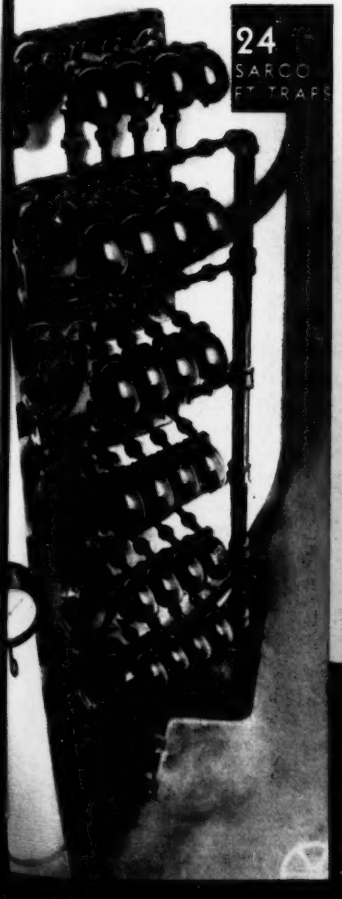
Concise G-A Valve descriptions enable you to choose among a large number of types for many purposes

No WRENCHES- No TROUBLE



YOU DON'T NEED TO WATCH SARCO STEAM TRAPS

Here is the proof before your eyes! Above—a No. 9 thermostatic trap on a tilting kettle that obviously hasn't seen a wrench for months. Below 24 Sarco Float-thermostatic traps on one starch drier—where each and every trap must operate at all times!

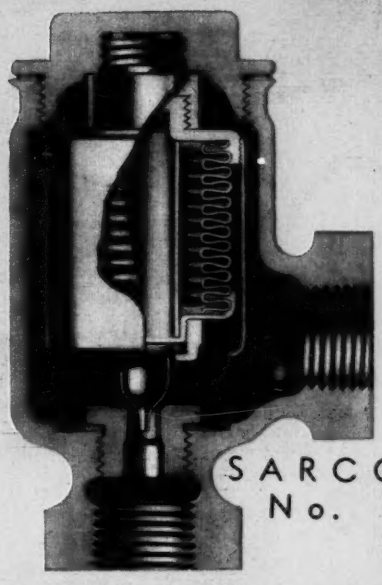


The reasons? First—a complete line to select from—the correct trap on every job. Second—a thermostatic element which is beyond question the outstanding achievement in the high pressure field. Third—Sarco men know industrial steam condensation and control problems.

Eighty percent of your requirements on high pressure will be met by one of the types of traps shown on this page. The other 20 percent is covered in our catalogs, and complete control systems are shown on the following page. You can safely standardize on Sarco—a company that can serve you on all these requirements. You can safely try Sarco on your hardest locations first.

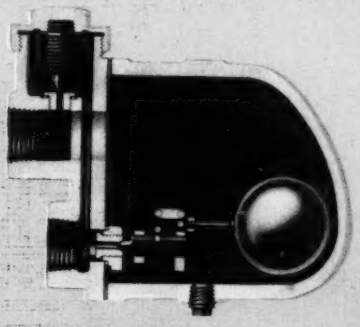
You cannot afford to continue to lose heat, steam, or production without looking into the outstanding service rendered by Sarco to industry during the past quarter century.

Ask for the new data book. Shows how to hook up all types of heating, air conditioning, and process equipment with suitable strainers, traps and controls. All sizes—all pressures.

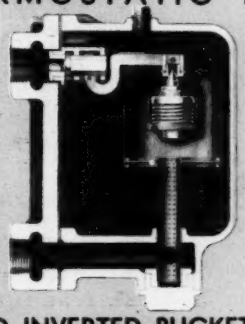


SARCO No. 9

HIGH PRESSURE THERMOSTATIC TRAP

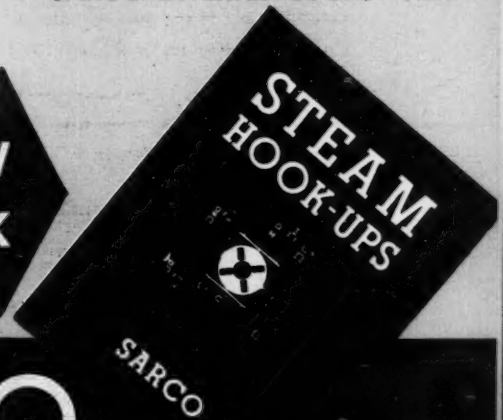


SARCO FLOAT AND THERMOSTATIC TRAP



SARCO INVERTED BUCKET TRAP

Ask FOR THIS NEW DATA BOOK

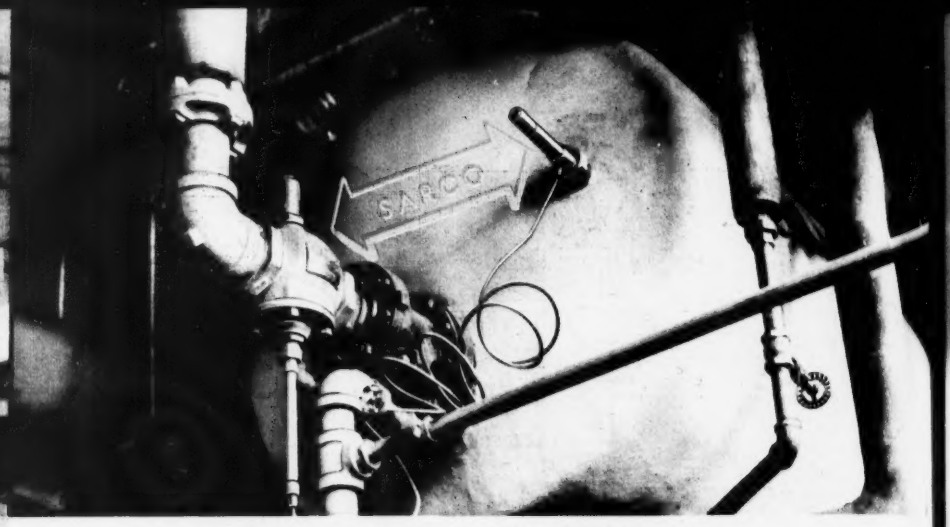


COMPLETE SYSTEMS FOR HEATING AND INDUSTRY

SARCO

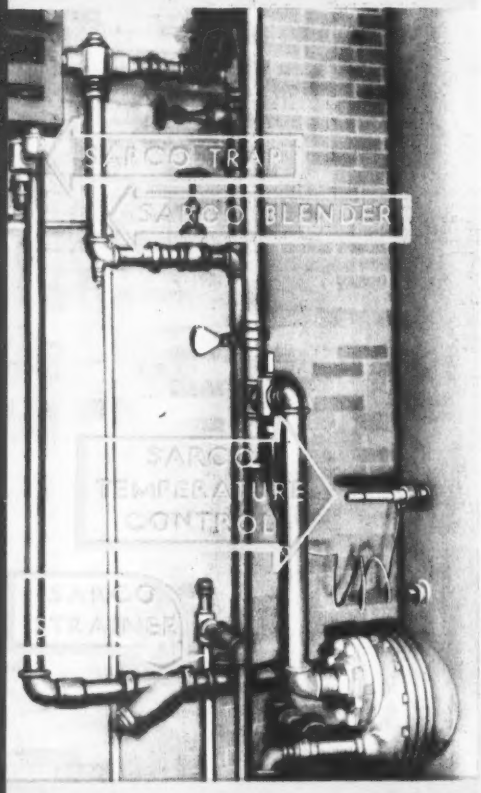
THERMOSTATIC, FLOAT AND BUCKET TRAPS, REGULATORS AND HEATING SPEC... ...S

SARCO COMPANY, Inc., 183 MADISON AVENUE, NEW YORK, N. Y.



ONE OF A BATTERY OF FOUR HOT WATER TANKS
WITH SARCO TEMPERATURE CONTROL

PROCESS TANKS



SARCO HOT WATER CONTROLS

What does it cost in your plant when the hot water temperature is 10 degrees too high or too low? You will be surprised to find how little it will cost to keep it just right with Sarco Temperature Control.

SARCO PROCESS TANK CONTROLS

Incorrect temperatures can ruin a week's production in dyeing, cooking, plating, and a score of similar processes. Sarco Temperature Control often saves its cost in a month. It will protect the smooth flow of production for years and save its weight in gold by conserving your fuel supply.
Installed anywhere—any process—any size.

SARCO CONTROL FOR AIR

Driers of all kinds can be controlled by various forms of Sarco Traps and Control. Ideal for industrial air conditioning where reliability and accuracy are paramount. Ask for Catalog 52 on Sarco Control.

SARCO HOT WATER BLENDER

Takes hot and cold water right from your main lines and blends it from any temperatures you have coming in—to any temperature you select coming out. Reduces tank sizes and piping—prevents scalding accidents in wash rooms—saves fuel. Also ideal for temperature control of cooling coils by recirculation. Catalog 140.

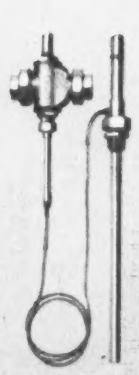
LOW COST—PROCESS TANK CONTROL

Make production temperatures ***all-automatic*** by using Sarco Thermoton on jacketed kettles, cookers, metal washers, plating tanks, etc. Also used for regulating temperatures in storage tanks heated with steam coils. Catalog 146.

AND SARCO HEATING SPECIALTIES

Sarco furnishes a service that is unique in three respects. The controls illustrated above are the only controls for those purposes operated by liquid pressure. Both the controls and Sarco high pressure traps have the Sarco Bellows which cannot be duplicated. In addition Sarco has a complete line of traps, valves, strainers, and controls for all industrial heating pressures.

So, you can standardize your plant ***only with Sarco.*** Get the advantages of Sarco and Standardization at one operation with one company to contact and to be held responsible.



TR-21 is standard for hot water storage tanks, blast heaters and many types of industrial process work.

KR-14 is designed for room control, dryers, kilns, refrigeration and cold storage.

COMPLETE SYSTEMS FOR HEATING AND INDUSTRY

SARCO

REPRESENTATIVES IN ALL PRINCIPAL CITIES

THERMOSTATIC FLOAT AND BUCKET TRAPS REGULATORS AND HEATING SPECIALTIES

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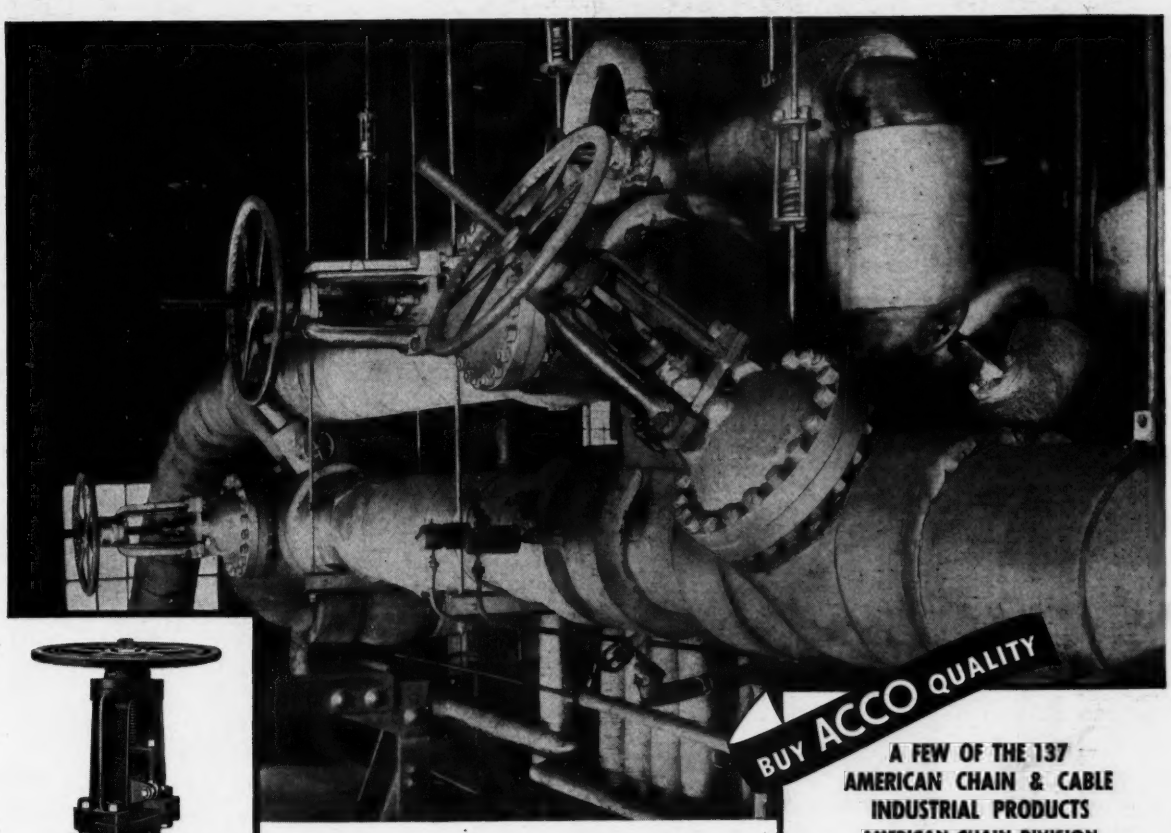
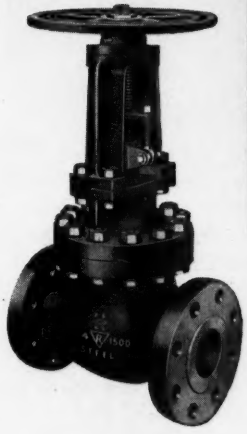


BUY ACCO QUALITY



FOR HIGH PRESSURES HIGH TEMPERATURES..

● Here is pictured an installation of Reading Steel Valves of several years ago—at the top ranges of temperature and pressure of its day. The single valve at lower left is today's valve corresponding to those in the installation.

Today a variety of alloys for main castings and metals for trims are offered according to the service—steam station, refinery or others. Now, as in the past, the materials and design of Reading Steel Valves are such as to give unfailing performance in the services for which they are recommended.

READING-PRATT & CADY DIVISION
AMERICAN CHAIN & CABLE COMPANY, Inc.
BRIDGEPORT, CONNECTICUT

In Business for Your Safety

A FEW OF THE 137 AMERICAN CHAIN & CABLE INDUSTRIAL PRODUCTS

AMERICAN CHAIN DIVISION
(DOMINION CHAIN COMPANY, Ltd., in Canada)
Weed Tire Chains • Welded and Weldless Chain • Malleable Castings • Railroad Specialties

AMERICAN CABLE DIVISION
Tru-Lay Preformed Wire Rope • Tru-Loc Processed Fittings • Crescent Brand Wire Rope Tru-Stop Brakes

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FORD CHAIN BLOCK DIVISION
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HAZARD WIRE ROPE DIVISION
Lay-Set Preformed Wire Rope • "Korodless" Wire Rope • Preformed Spring-Lay Wire Rope • Guard Rail Cable

HIGHLAND IRON & STEEL DIVISION
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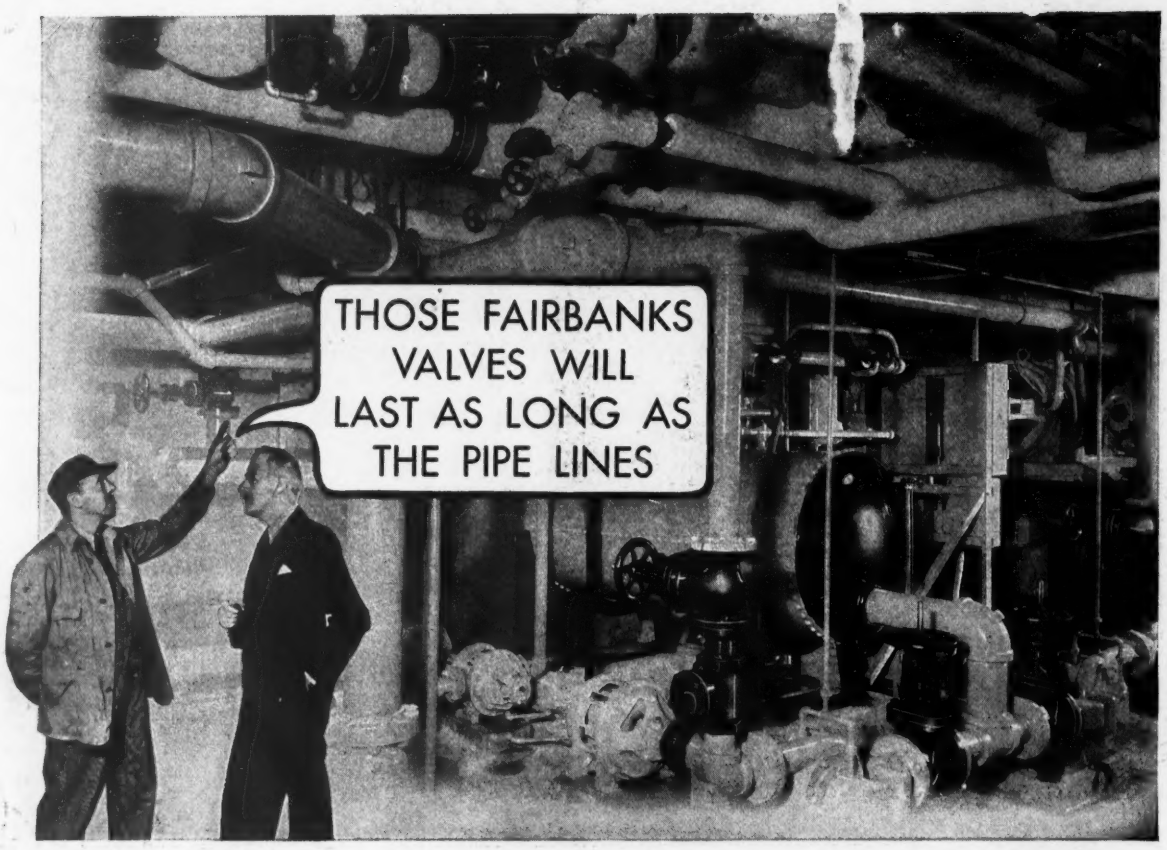
READING-PRATT & CADY VALVES

ACCO QUALITY VALVES • MADE IN A PLANT DEVOTED EXCLUSIVELY TO MANUFACTURING VALVES



You'd probably be astounded if you knew what a large sum it costs you every year for valves that employees scrap simply because the inexpensive seats or wedges are worn.

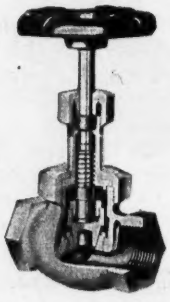
You can stop that deplorable waste by replacing antiquated valves with Fairbanks RENEWABLE Valves, for they last as long as the pipe line.

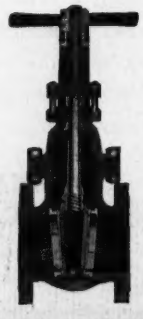
The seat rings or wedges may eventually wear, but they can be replaced in a few minutes by one man without removing the valve from the line. And instead of paying, say $5.00 for a new valve, you simply pay about 65c for new seats. Multiply that $4.35 saving with the number of new valves you buy every year!

You will find many other money-saving achievements in Fairbanks Renewable Valves. Learn the facts about these valves before you buy. Compare them for yourself, feature for feature. Then buy on value alone.

We are so certain that Fairbanks Renewable Valves will save you money that we are willing to send one for a 30 day trial. If you are not perfectly satisfied, return it and we will make no charge.

Write now for a copy of our Catalog No. 21.





THE FAIRBANKS COMPANY

Valves, Dart Unions, Hand Trucks and Wheelbarrows

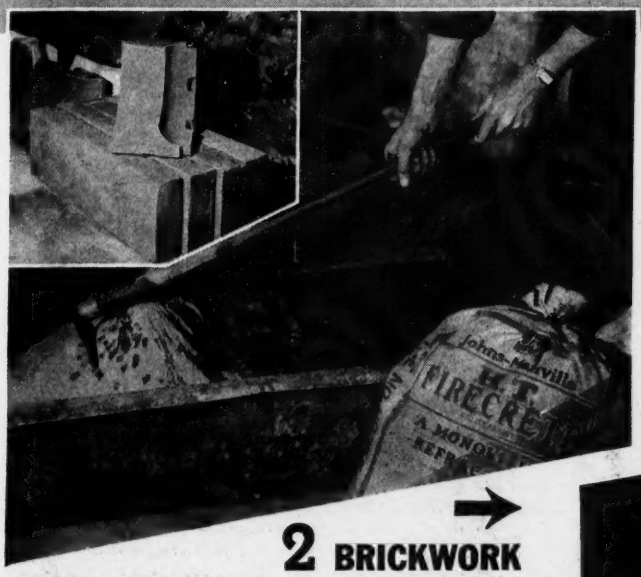
399 Lafayette St., New York, N. Y.

Boston • Pittsburgh • Distributors in Principal Cities

Factories: **Binghamton, N. Y. • Rome, Ga.**

Fairbanks Renewable Valves

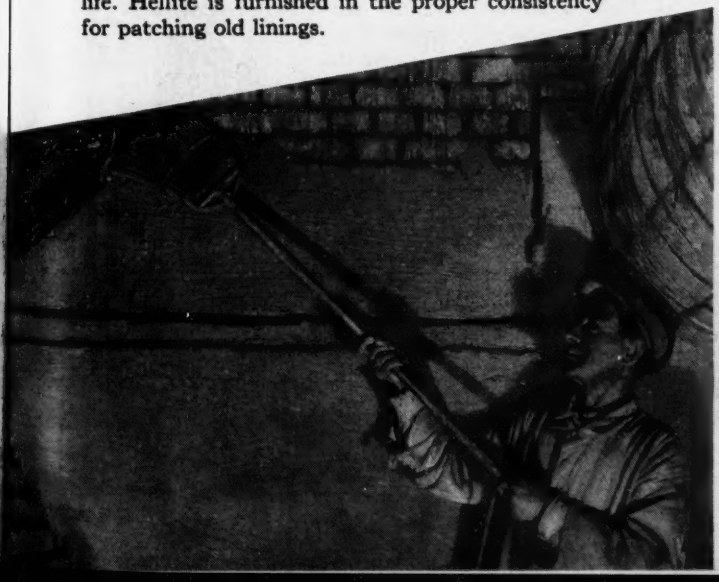
HOW J-M REFRACTORY CEMENTS CAN CUT YOUR MAINTENANCE COSTS



1 SPECIAL SHAPES CAN BE CAST IN YOUR OWN PLANT. Much money and time can be saved by casting special shapes yourself—and eliminating the need for stocking infrequently used, high-priced shapes. J-M Firecrete, hydraulic-setting and handled like concrete, is ideal for cast door linings, flues and pipes, for dampers and special shapes. Three types: Standard (2400° F.), High Temperature (2800° F.) and Light Weight (2400° F.).

2 BRICKWORK MUST BE PROTECTED AT EDGES. Tightly bonded joints assure longer refractory life by protecting brick edges against the destructive effect of flame impingement, slagging and the action of furnace gases. Make sure of tightly sealed joints by setting firebrick with Johns-Manville Refractory Cements—J-M No. 31 (dry, heat-setting) for bond or cushion joints; J-M No. 32 (dry, heat-setting) for brick-to-brick joints; J-M Hellite (ready mixed, air-setting) for either type of joint.

3 FURNACE WALLS SHOULD BE WASHCOATED. Washcoating, by filling brick pores, presents a smooth surface that retards clinkering, minimizes erosive action of oil flame and slagging of brick by low-fusion ash. Washcoating with J-M Hellite (air-setting) or J-M No. 32 (heat-setting) will cut down maintenance and lengthen life. Hellite is furnished in the proper consistency for patching old linings.

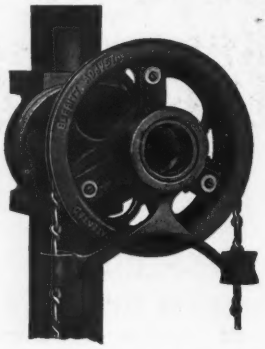


FOR OVER A QUARTER OF A CENTURY, Johns-Manville has been supplying a dependable line of refractory cements for minimizing refractory maintenance and increasing refractory life. The more important of these materials are described briefly above. For full details on all J-M Refractory Products, write for our engineering brochure D. S. 700. Johns-Manville, 22 E. 40th Street, New York, N. Y.

JM JOHNS-MANVILLE POWER PRODUCTS

Refractories Packings Insulations

For All "HIGH-UP" VALVES



Every overhead valve in your plant should have the easy, safe, instant control from the floor which Babbitt Sprocket Rims provide. . . . Babbitt Rims are low in cost; quickly attached; they save time, steam and accidents. Install them now. Write for descriptive folder.

BABBITT STEAM SPECIALTY CO.

New Bedford, Mass., U. S. A.

Babbitt

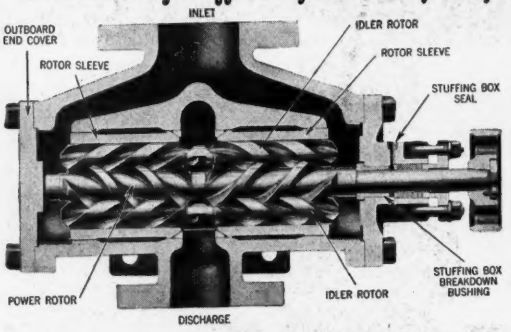
—Adjustable—

SPROCKET RIM

with Chain Guide

DE LAVAL-IMO OIL PUMPS

Combine High Efficiency with Simplicity



THE operating parts consist of the central or power rotor, flanked by the two sealing rotors, these three rotors being the only moving parts. This very simplicity insures freedom from trouble in operation. *Removal of the coupling half and the outboard end cover gives access to all working parts,* without disturbing the suction and discharge piping or the prime mover. The novel design of the rotors, the absence of pilot gears and the elimination of all but one stuffing box, each contributes to high efficiency, thus saving power.

Ask for Catalog L-18 or let our engineers recommend a De Laval-IMO pump suitable for your particular requirements

DE LAVAL STEAM TURBINE COMPANY

Trenton, New Jersey

Use **VULCODISC**

for trouble-free valve jobs

In renewing the disc, note how easily and quickly the Vulcodisc Jiffy Disc Holder slips off the stem head. Only the disc lock nut to remove and the old disc is off and replaced in a jiffy.

Dense without being brittle—tough, yet resilient, Vulcodisc will not swell, warp or soften — in fact its absorption is less than 1 per cent. . . That is why an old Vulcodisc comes out of the disc holder as easily as a new one goes in. No need for hammer and chisel to cut the disc out in pieces—distorting and disfiguring the holder. Write for descriptive bulletin.

THE D. T. WILLIAMS VALVE CO.

Cincinnati, Ohio

PIPEWRENCH PETE SAYS:

LET THE TIGHT-ROPE WALKERS WORRY

"Used to be a worry wart, I did, on how to get inverted traps to work. Buckets balanced, traps would spit and dribble. Then I discovered Strong Traps with their patented anti-balancing device. Further down the bucket goes, the wider the vent. Let the tight-rope walkers worry about balance from now on. I'm sticking to fast-action, anti-balance Strong Inverted Traps."

Write for Bulletin 62X on Strong Steam Traps

STRONG

STEAM TRAPS

The Strong, Carlisle & Hammond Company
1392 West Third Street, Cleveland, Ohio

Inspect the MACHINE WORK *of any Kennedy Valve*

THE large Kennedy line includes bronze and iron body gate, globe, angle and check valves for low, standard, medium and extra heavy pressures. Each type has several "extra value" features that make Kennedys the best possible valve investment. Specify Kennedys on your next valve order and you will quickly see the advantages of standardizing on them. Obtainable at your local dealer.

NOTICE the smooth, true surfaces, accurate threading, clean finish and perfect fit of all parts. Kennedy machinists are long-experienced, and the strictly modern automatic machine tools with which they are provided enable them to turn out flawless work.

The result—Kennedy Valves look trim and clean-cut; and, more important, they operate easily, close tightly, are readily taken apart and reassembled, and all parts are interchangeable.

The Kennedy Valve Mfg. Co., Elmira, N. Y.

KENNEDY

VALVES-PIPE FITTINGS-FIRE HYDRANTS

UPSIDE DOWN.. BUT THEY HANG ON!

Snap-on Socket Wrenches

Blue-Point Mechanic Tools

Double-broached, precision-built sockets —therefore snug fitting in any position!

Besides, Snap-on Heavy Duty Loxockets automatically lock on to every handle . . . yet are removed easily at the touch of a thumb button!

No. 477 MasterMech Set

—illustrated, contains tiny tools for adjusting small motor parts, etc., taking nuts down to ¼" across the flat up to eight Heavy Duty Loxockets 1 1/16" to 1⅝" opening size, providing you with a complete balanced selection of 28 sizes within that range. Handles included run from a 4½" tiny Midget Sliding Bar Offset to the powerful Heavy Duty L-72N Ratchet with 24½" leverage (shown in actual use).

Snap-on builds a complete line of hand tools . . . available through its own distributing warehouses located in 37 principal cities. For immediate service, call Snap-on Tools listed in your phone directory, or mail coupon for FREE 136-page catalog.

SNAP-ON TOOLS, Inc.,
KENOSHA, WIS.

☐ Without obligation, have representative demonstrate Snap-on MasterMech Set No. 477.

☐ Send FREE catalog.

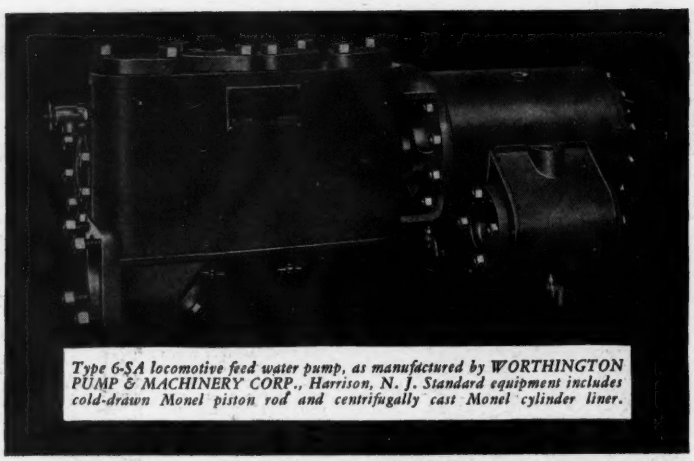
Name .....

Firm .....

..... PPE-12

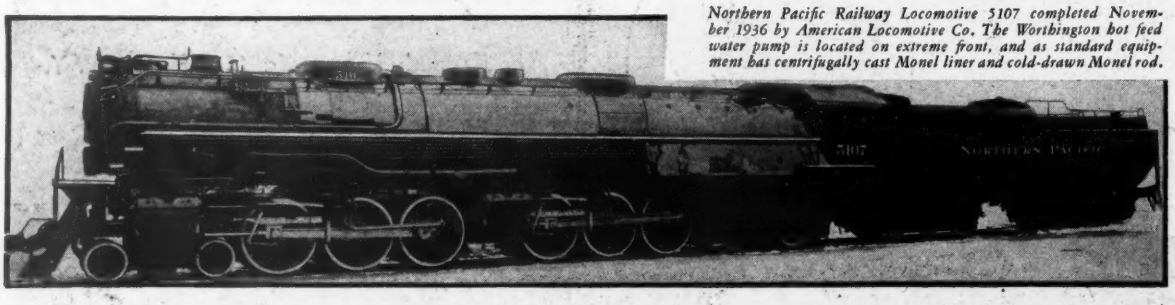
With Design Improved for

MODERN SERVICE..



Type 6-SA locomotive feed water pump, as manufactured by WORTHINGTON PUMP & MACHINERY CORP., Harrison, N. J. Standard equipment includes cold-drawn Monel piston rod and centrifugally cast Monel cylinder liner.

WORTHINGTON CONTINUES MONEL

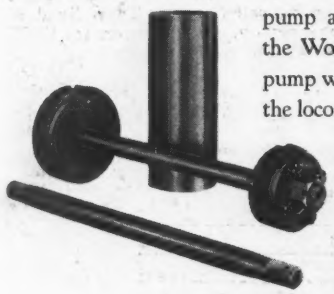


Northern Pacific Railway Locomotive 5107 completed November 1936 by American Locomotive Co. The Worthington hot feed water pump is located on extreme front, and as standard equipment has centrifugally cast Monel liner and cold-drawn Monel rod.

New feed pump exposed to wind and weather needs tough, corrosion-resistant parts

PERCHED out front on Northern Pacific locomotive 5107 is the new Worthington type 6-SA feed water pump shown in the above close-up. Some place you'll agree, for a pump with exposed rod. Tearing along through wind, dust, grit and sleet, the rod in this pump can take it. Why? Like the cylinder liner, it's made of Monel.*

Monel got this tough assignment only after thoroughly proving itself. For fifteen years Monel liners and Monel pump rods have been standard in Worthington locomotive feed pumps. Formerly combined in one unit with cold water pump and feed water heater, the Worthington water heater pump was located at the side of the locomotive. In the new type 6-SA feed water heating and pumping equipment, these units are separated to effect more even distribution of weight. And the direct acting hot water pump, with inter-cylinder section of the Monel pump rod exposed, is now set way out on front of the locomotive in the wind and the weather.



Cold-drawn Monel horizontal reciprocating pump rod and centrifugally cast Monel cylinder liner for type 6-SA hot water locomotive boiler feed pump above.

Can Monel handle this job? Ask Worthington—here's what they'll tell you: First: that cold-drawn Monel pump rods retain their hard, polished surface—so work smoothly in glands, *protect* the packing. Second: that Monel, because of its stout resistance to corrosion, erosion and abrasion, is good for years of dependable, trouble-free service no matter where you put it.

When buying new pumps specify Monel for rods and liners. And, when overhauling worn equipment, specify this tough, corrosion-resistant metal for *spare* rods and liners, too. Write for further information. Ask for our booklet, "Strength Plus". Address:

THE INTERNATIONAL NICKEL COMPANY, INC.
67 WALL STREET NEW YORK, N. Y.

*Monel is a registered trade-mark applied to an alloy containing approximately two-thirds Nickel and one-third copper. This alloy is mined, smelted, refined, rolled and marketed solely by International Nickel.

ALWAYS IN THE SPOTLIGHT

The name Powell has always been in the spotlight. Fine workmanship and built-in stamina have made Powell bronze valves the first consideration of the plant engineer.

Our technical department will gladly assist you in your valve problems.

POWELL VALVES

THE WM. POWELL CO. CINCINNATI, OHIO

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TO-PURCHASING DEPARTMENT
Let's get four more of those powerful new Roto Senior Tube Cleaners.
The one we recently bought reduced our best former cleaning time by 66%.
CHIEF ENGINEER
WRITE FOR DETAILS

THE ROTO COMPANY
145 SUSSEX AVE. NEWARK, N. J.

See Our Adv. in SWEET'S

and for Small Tubes-ROTO Junior

"PBH" GAUGE COCK

A gentle pull opens this sturdy, long-wearing gauge cock and an adjustable weight automatically closes it when you let go. Quickly renewable Valve Pencil of special metal. Fully guaranteed. Write today for details and prices.

The PAUL B. HUYETTE CO., Inc.
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401 N. BROAD ST. PHILADELPHIA, PA.

WATER GAUGES—*Vertical and Inclined*
GAUGE-GLASS PROTECTORS • AIR-TIGHT
BOILER WALL COATING • WATER COLUMNS •
BOILER ALARMS, INSTRUMENTS & CONTROLS

BRASSERT Automatic Strainer

Removes suspended solids from liquids, operates continuously and automatically—strainer openings from 1/16" to 1/64"—Sizes from 2" line connection up to 30 inches.

Water enters connection at one side of strainer and leaves from the side opposite through a similar opening. Straining elements are porcelain discs perforated by tapered parallel holes inserted in holders in the walls of a cast iron cylinder. Rigid alignment is secured by roller or stellite bearings. Water passes from outside of cylinder to center, thence to outlet. Cylinder is slowly revolved and strainer discs are back washed into waste compartment once each revolution. About 5% of clean liquid is used in backwashing. Differential pressure between clean compartment and waste compartment is adjustable. Strainer is adapted to granular material and also to fibrous substances which clog an ordinary strainer. Speed of revolution is adjustable to suit the necessities of solid removal. A large number of strainers are in use in very exacting services.

WRITE FOR BULLETIN.

H. A. BRASSERT & COMPANY, *Engineers and Contractors*
310 SOUTH MICHIGAN AVENUE CHICAGO, ILLINOIS

YOUR BOILERS NEED • • SOFT WATER • •

WE MANUFACTURE ALL SIZES AND TYPES OF WATER SOFTENERS & FILTERS

Cold Process: Intermittent, Continuous and Zeolite. Hot Process, Semi-Hot Process and specially designed Water Softeners.

Gravity, Pressure and Oil Removal Filters.

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You take no chances

in specifying Hercules Seamless Copper Floats. More than 624,000 in service offer convincing proof of the unfailing, low-cost service they deliver. Guaranteed for working pressures up to 350 lbs. Write us about your float problems.

HERCULES FLOAT WORKS
215 Franklin St., Springfield, Mass.

HERCULES

THE ORIGINAL
SEAMLESS COPPER FLOATS

KOPPERS KOPPERS

Controlled Quality Coal

Running an ash-fusion test. To assure accuracy, two independent temperature checks—optical pyrometer, and potentiometer—are regularly used.

RIGHT—Preparing a sample of ash for the ash fusion temperature test. When grinding is completed, ash will pass a 200 mesh screen.

TO SAVE FOR YOU . . . KOPPERS MAINTAINS ONE OF THE MOST COMPLETE COAL LABORATORIES IN THE COUNTRY

Efficient plant operation is vitally affected by the properties and the uniformity of the coal. The completely equipped Koppers Laboratory carries on a continuous program of check analyses that maintains uniformity, car to car and day to day. Illustrated are typical laboratory scenes showing steps in one of the numerous tests that are regularly conducted.

Other Koppers Coals are subjected to the same continuous control, offer similar efficiency and economy advantages. A Koppers representative will give you full details.

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NATIONAL LUMBER & CREOSOTING COMPANY — TEXARKANA, ARK.-TEX.
BARTLETT HAYWARD DIVISION — BALTIMORE, MD.
AMERICAN HAMMERED PISTON RING DIVISION — BALTIMORE, MD.
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Koppers Principal Products for the Power Field

Koppers Coal . . . Treated Poles . . . Treated Cross-Arms . . . Other Treated Timber . . . Coal Tar Pitch Roofing . . . Waterproofing . . . Dampproofing . . . Fast's Self-aligning Couplings . . . Tank Work . . . Western Valves . . . Steel Plate Construction . . . American Hammered Piston Rings . . . Koppers D-H-S Bronze Castings . . . Iron Castings . . . Materials-Handling Systems . . . Tarmac for Paving . . . Western Fire Hydrants . . . Pipe . . . Western Cooling Coils . . . Special Machinery . . . Western Condensers . . . Western Controls . . . Steam Accumulators . . . Coke . . . Barges . . . Disinfectants . . . Weed Killers . . . Deodorants . . . Insecticides . . . Lighters.

THE KOPPERS COAL COMPANY
Koppers Building Pittsburgh, Pa.

Specialized for Each Application

AMERICAN HAMMERED PISTON RINGS

USED BY AMERICA'S LEADING ENGINE BUILDERS

EVERY SIZE · **EVERY TYPE** · **FOR EVERY PURPOSE**

Pictured is an installation of Ingersoll-Rand XVG Gas Engine Driven Compressors in a gasoline plant. American Hammered Step Seal rings, and Scraper Drain Oil rings are used. The former combine the strength of the single-piece ring with the sealing qualities of the multiple-piece ring. The latter ride over the oil on the cylinder wall on the up-stroke, scrapes oil into the groove on the down stroke, protects walls from wear.

Ingersoll-Rand Compressors are in use in dozens of industries, the world over. The company has used American Hammered Piston Rings for many years.

KOPPERS COMPANY
AMERICAN HAMMERED PISTON RING DIVISION
Baltimore, Md.

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Making a "Megger" Test

You can do a better maintenance job with

"MEGGER" INSTRUMENTS

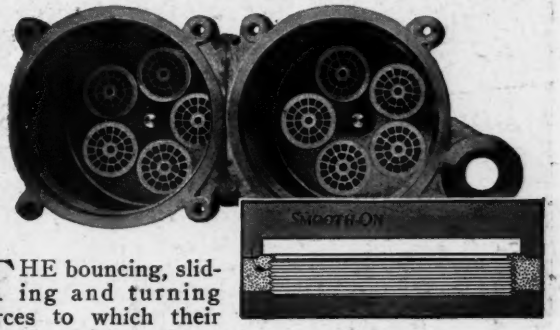
You inspect, why not test and be sure? By making "Megger" tests of insulation resistance, you can detect insulation weaknesses in advance of failure, and go far towards making electrical maintenance what it should be—a means of forestalling trouble. "An ounce of prevention is worth a pound of cure." Write for descriptive "Megger" Bulletin 1355-PE.

JAMES G. BIDDLE CO.

ELECTRICAL INSTRUMENTS

1211-13 ARCH STREET PHILADELPHIA, PA.

RENEWABLE VALVE SEATS and SEAT RINGS will not wear, turn or work loose at the threads if they are set with SMOOTH-ON NO. 3



THE bouncing, sliding and turning forces to which their work subjects these parts naturally invites loosening. Once a seat or ring moves, it continues to move at a rapidly increasing rate, with excessive wear, chatter, leakage of fluid, and ultimate destruction. The right way to avoid these faults and the repair expense they involve, is to **stop them before they start.**

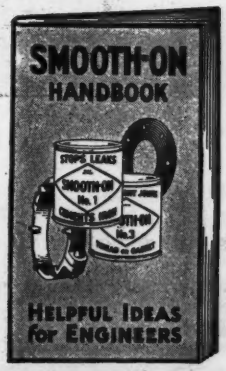
Set the threads in Smooth-On No. 3, and the bond cannot loosen until intentionally broken in disassembling. Joints so made will remain perfect in the presence of hot or cold water, steam of any temperature, thin oils and most chemical fluids.

To stop leaks at *worn or undercut* threads of valve discs and disc rings use Smooth-On No. 1

WHERE wire-drawing, grit, chemical action or up-and-down movement has weakened old threads, you can restore thorough and permanent tightness by resetting the threads in a thick batter of Smooth-On No. 1. The expansion of the Smooth-On No. 1 in hardening fills all the voids, makes the joint as dependable as when new, and the seat or ring will never twist. This method takes only a few minutes and offers a big saving over reboring and retapping of deck or body and fitting with a new oversize part.

Smooth-On No. 3 and Smooth-On No. 1 are so useful and practical in hundreds of routine and emergency repairs that they should be in the supply room of every power plant.

Buy in 1 or 5-lb. can or in larger keg from your nearest dealer or if necessary direct from us.



The SMOOTH-ON HANDBOOK FREE if you return the coupon

Contains diagrams, pictures and practical hints on at least 200 different uses for Smooth-On. Every progressive engineer should have this book—get your copy NOW.

SMOOTH-ON MFG. CO., Dept. 31, 570 Communipaw Ave., Jersey City, N. J.
Please send the SMOOTH-ON HANDBOOK.

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Do it with **SMOOTH-ON**

RIGHT TYPE for EVERY SERVICE

TURBINE PUMPS

CENTRIFUGAL PUMPS

RECIPROCATING PUMPS
Simplex and Duplex Types

Somewhere in this broad line of modern, highly-efficient Turbine, Centrifugal and Reciprocating Pumps is exactly the equipment you need, no matter what your pumping problem. American-Marsh engineers can help you get results with UTMOST economy. We have done it a thousand times before! Write us for bulletins.

To better associate our Company name with our long established trade name—American-Marsh—we recently adopted the new Company name used in the signature below.

However, there has been NO CHANGE in financial structure, management, or quality standards maintained for over 60 years.

AMERICAN-MARSH PUMPS, INC.

Centrifugal, Turbine, Steam, and Power Pumps

BATTLE CREEK . . . . MICHIGAN

Is your Feedwater treatment OUT DATED?

Possibly Not—

yet chances are your power house could enjoy better boiler water conditions.

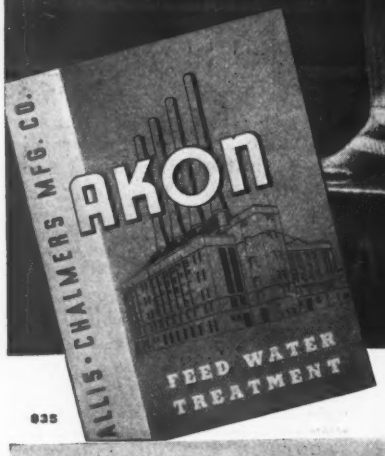
The use of a feedwater treatment and service should be compared to employing a traveling engineer.

His accomplishments and references should be outstanding. For like feedwater treatment his work will be dependent upon his ability and experience.

Allis-Chalmers offers you the highest recommendations. Akon has a solid reputation in the power plant field.

As insurance for your boilers you can depend upon results.

An "A-C Feedwater Survey" tells you—based on facts.



835

WRITE FOR ENGINEERING BULLETIN 1542

EQUIPMENT ENGINEERS TO INDUSTRY

ALLIS-CHALMERS

MILWAUKEE, WISCONSIN

TIMKEN

TRADE MARK REG. U. S. PAT. OFF.

The trade mark "TIMKEN" identifies a growing family of American-made quality products. This family now numbers 6, including the TIMKEN Tapered Roller Bearing born more than 40 years ago. All are noted for outstanding performance in their various spheres, as listed below. It will pay you to make this trade-mark your guide when buying such products as those it is associated with.

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TAPERED ROLLER BEARINGS

Used and preferred in leading makes of automobiles, trucks, tractors and industrial equipment of all kinds.

TIMKEN
RAILWAY ROLLER BEARINGS

For locomotives, cars and streamlined trains. An impressive majority of American locomotives and streamliners are Timken-equipped.

TIMKEN
ROCK BITS

Have revolutionized rock drilling and rock drilling costs in mines, quarries and construction work. Drill faster last longer.

TIMKEN
ALLOY STEELS

Electric furnace and open hearth. Manufactured in all standard and special analyses. Noted for high quality and consistent uniformity.

TIMKEN
SEAMLESS STEEL TUBES

For all mechanical purposes and high temperature applications. Quality controlled from raw material to finished product.

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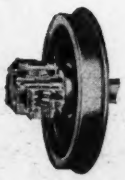
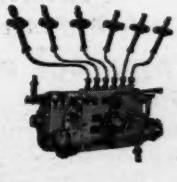
FUEL INJECTION EQUIPMENT

For Diesel and semi-Diesel engines of 1 to 8 or more cylinders. Assures increased power, smoother operation and greater economy.





THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

Is Your Wife a ROD PACKER'S WIDOW?

IF YOU want to spend more Sundays and holidays at home with your family rather than at the plant repacking leaky pump and engine rods, insist on Chesterton Number "64".

"64" is the engineer's standby because its DIAGONAL Construction makes its plies extra compressible. By tightening the gland as the packing wears, you can easily renew the surface of "64" again and again.

Remember, too, that "64" is a non-hardening packing because it is held together by an improved cement that will not "grow hard." It has no rubber back because it needs none! Successfully retains its toughness and flexibility on all steam, gas, hot oil and other gruelling service.

Only with genuine "64" can you obtain "64's" longer packing life and better economy. In sizes from 1/4 in. up. Order today and also ask for the Chesterton Packing Chart which will be sent without charge.

A. W. CHESTERTON CO.

64 India Street **Boston, Mass.**

MID-WEST DIST.

ADVANCE PACKING & SUPPLY CO.

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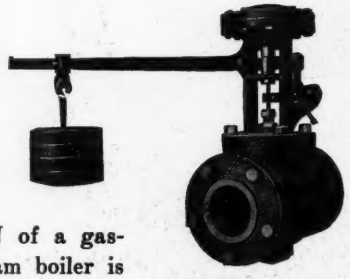
PACKING Chesterton SERVICE

No Blowing Off—Steady Pressure at All Times



FULTON GAS-FUEL BOILER GOVERNOR

OPERATION of a gas-fuelled steam boiler is economical and regular where the Fulton Gas-Fuel Boiler Governor is used. No blowing off ever occurs. Steam never drops below working pressure, but is held constant at any pressure from 1 to 150 pounds as desired. Write for Bulletin No. 1182.

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The Chaplin-Fulton Mfg. Co.

28-40 Penn Avenue Pittsburgh, Pa.

INSIST ON mono-therm INDICATING THERMOMETERS!

Summed up it means just this: Foxboro mono-therm Dial-Type Thermometers give you the most for your money . . . and you can always read them. The Foxboro Company, 70 Neponset Avenue, Foxboro, Massachusetts, U. S. A. Branch Offices in 25 Principal Cities.

they give you:

mono-therm system—The finest thermal unit construction.

Accuracy—Precision over the entire scale range. Each instrument individually calibrated.

Maximum Visibility—From a distance of 20 feet and at a wide angle the 12-inch long scale is easily read.

Flexibility of Location—The indicator may be located as much as 200 feet away from the bulb. A number of instruments may be grouped where convenient.

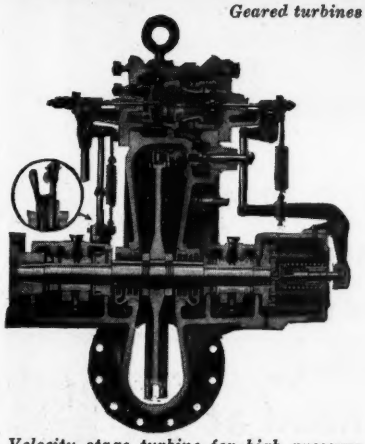
Longer life—Less wear...no leakage...and least danger of breakage.

Individual Certification—Your guarantee of satisfactory instruments and dependable performance.

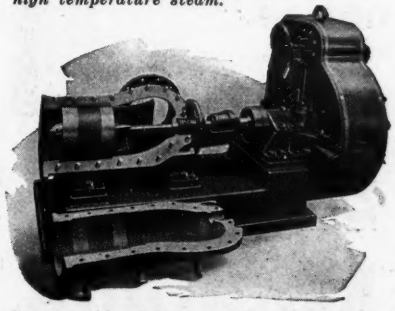
FOXBORO
REG. U. S. PAT. OFF.

Certified INDICATING THERMOMETERS

Geared turbines for driving induced draft fans, designed to use steam at 475 lb. gage.



Velocity stage turbine for high pressure, high temperature steam.



Steam turbine driven propeller circulating pump.

WHERE there is some use for the exhaust steam, both plant efficiency and reliability can be greatly improved by installing steam driven auxiliaries.

For many purposes, such as driving high pressure centrifugal pumps, centrifugal blowers, propeller pumps, De Laval-IMO oil pumps, and small generators, the steam turbine and the driven machine can be directly coupled.

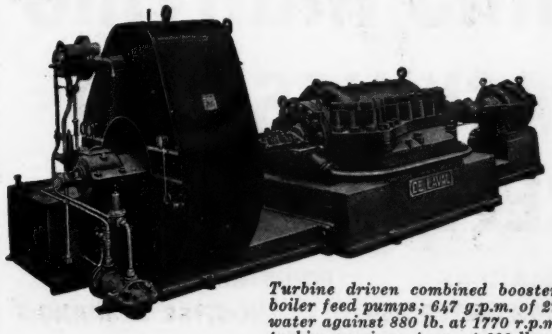
With slow and moderate speed machinery, such as low head pumps and fans, DC generators, conveyors, pulverizers, etc., high efficiency and other desirable operating characteristics for both turbine and driven machine can be realized by transforming the speed by means of De Laval Helical Gears or De Laval Worm Gears.

Every De Laval unit is designed to work together as a whole, and is assembled, tested and guaranteed by a single and reliable organization, responsible for all parts of the unit and for their proper coordination.

Advice and data relating to steam turbine drives will be supplied by us upon receipt of a statement of your conditions.

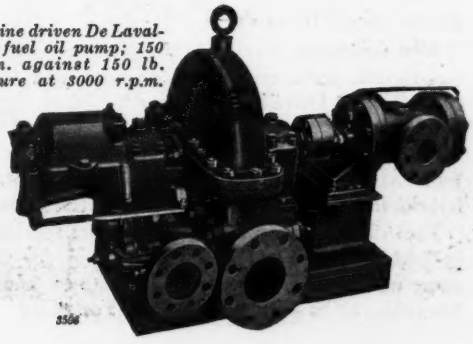
DE LAVAL STEAM TURBINE CO.

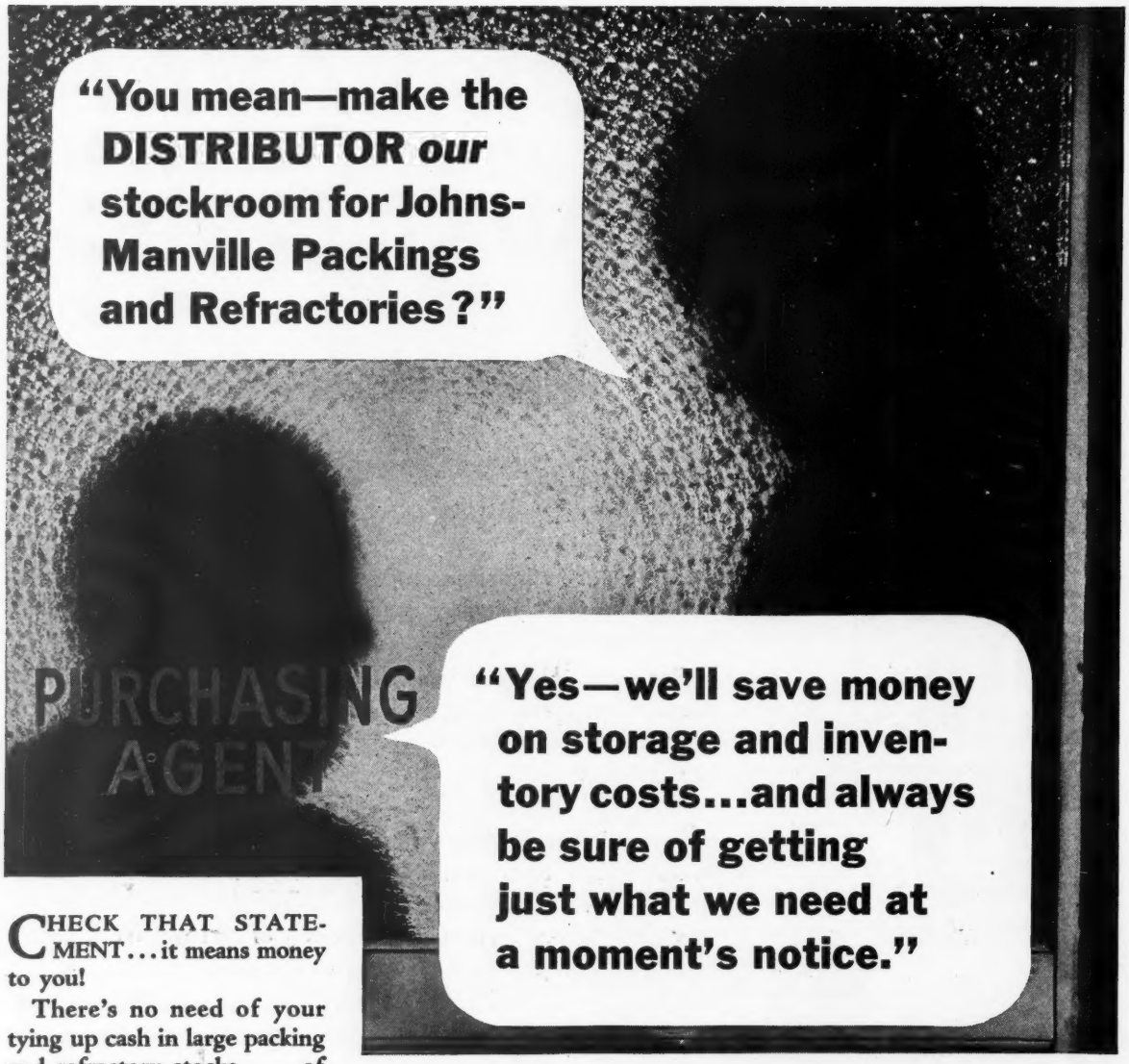
TRENTON, NEW JERSEY



Turbine driven combined booster and boiler feed pumps; 647 g.p.m. of 275° F. water against 880 lb. at 1770 r.p.m. The turbine receives steam at 600 lb. per sq. in. and 850° F.

Turbine driven De Laval-IMO fuel oil pump; 150 g.p.m. against 150 lb. pressure at 3000 r.p.m.




"You mean—make the DISTRIBUTOR *our* stockroom for Johns-Manville Packings and Refractories?"
PURCHASING AGENT
"Yes—we'll save money on storage and inventory costs...and always be sure of getting just what we need at a moment's notice."

CHECK THAT STATEMENT... it means money to you!

There's no need of your tying up cash in large packing and refractory stocks . . . of using up otherwise valuable storage space. And even when you do, the particular packing or refractory needed is often "among the missing" . . .

But consider this: A highly rated distributor, carrying J-M Packings and Refractories, can serve you *promptly* from a more complete stock than you could possibly want or profitably afford to carry.

And remember this, too. You can be sure of satisfaction with every J-M product you buy through J-M Distributors. Over 50 years spent in developing packings and refractories, and in servicing every industrial need, are behind these Johns-Manville products today. Their dependability, durability and economy are a matter of record.

For information on the characteristics and uses of J-M Packings and Refractories, and for the name of the nearest distributor, write to Johns-Manville, 22 E. 40th Street, New York City.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville

PACKINGS AND REFRACTORIES

INSULATIONS
INDUSTRIAL FLOORING
FRICTION MATERIALS
ROOFING & SIDING
ELECTRICAL CONDUIT

Don't mistake "faithfulness" for efficiency. Check over the operating and maintenance cost records of your pumps for the last few years. Chances are that your findings will parallel those of other plants where many a "faithful" pump has been shown to be a power-hog. Replacements with modern, efficient Warren Pumps have helped many industrial plants to make worthwhile, continued savings on power and repair costs. Consult Warren on your pumping problems. Ask for a quotation on replacements or additions.

WARREN PUMPS

WARREN STEAM PUMP COMPANY, INC., WARREN, MASSACHUSETTS

4275

PIPEWRENCH PETE SAYS:

THE CHIEF GOT RUN OVER BY AN ENGINE

Told me he used to go home nights wondering whether the fly-wheel would still be there in the morning, or over in the next county.

Finally, one night, a nightmare engine runs over him. He ups and gets on his clothes, dashes for the plant, and gets there just in time to stop some real damage.

But the chief sleeps like a baby now. He put in one of those Strong Automatic Engine Stops. Foolproof and sure-acting they are, too. And, as the chief says, the thing's got a brain better'n a human being.

Write today for Bulletin 251

STRONG

AUTOMATIC ENGINE STOPS

The Strong, Carlisle & Hammond Company
F 1392 West Third Street, Cleveland, Ohio

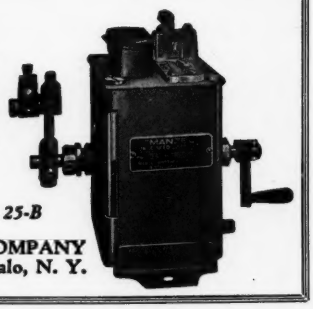
MANZEL FORCE FEED LUBRICATORS

Model "25"

Provide positive automatic lubrication for engine, pump and compressor cylinders.

Start and stop with the engine and automatically feed the exact amount of oil needed at every speed without change in adjustment.

Reduce oil bills 30% to 60%.



Write for Catalog No. 25-B

MANZEL BROTHERS COMPANY
327 Babcock St. Buffalo, N. Y.

This Is The Cleaner

For Water Tube Boilers

Dean for Straight Water Tubes

THOROUGH — DURABLE

Easy to use—Inexpensive to maintain

Write for full information

THE WM. B. PIERCE CO. 149 Ellicott St. Buffalo, N. Y.

Eliminate Needless Dangers with a

Squires BOILER FEED WATER CONTROLLER

Undue strains on the boilers can be eliminated by installing this simple and reliable feed water controller. It will shoulder human responsibilities with exacting precision.

Write for full particulars E-12.

THE C. E. SQUIRES CO.

E. 40th ST. AND KELLEY AVE. CLEVELAND, OHIO

Trade Mark Reg. U. S. Patent Office

Win the battle against scale!

ELIMINATE sludge and scale-forming matter once and for all with the proven "Elgin System." Elgin alone offers the correct water treatment to suit your conditions *plus* the efficient deconcentration principle. Ask for the new booklet: "The Inside Story of Boiler Water Conditioning."

ELGIN SOFTENER CORPORATION, 57 North St., Elgin, Ill.

ELGIN CORRECT CHEMICAL TREATMENT *plus* DECONCENTRATION

BROWN THERMOMETERS

Pyrometers
CO_2 Meters
Tachometers
Hygrometers
Flow Meters
Pressure and
Vacuum Gauges
Motorized Valves
Liquid Level Gauges

Electric or Air Operated

Indicating, Recording, Controlling, Signalling

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The Brown Instrument Co., a division of Minneapolis-Honeywell Reg. Co., 4491 Wayne Ave., Philadelphia, Pa. Offices in all principal cities. Toronto, Canada: 117 Peter St. . . . Amsterdam-C, Holland: Wijdesteeg 4. . . . London, England: 70 St. Thomas' St., S. E. 1.

To Measure and Control is to Economize

PERMUTIT ANNOUNCES

ZEO-KARB H

HYDROGEN ZEOLITE

REVOLUTIONARY NEW FEEDWATER TREATMENT

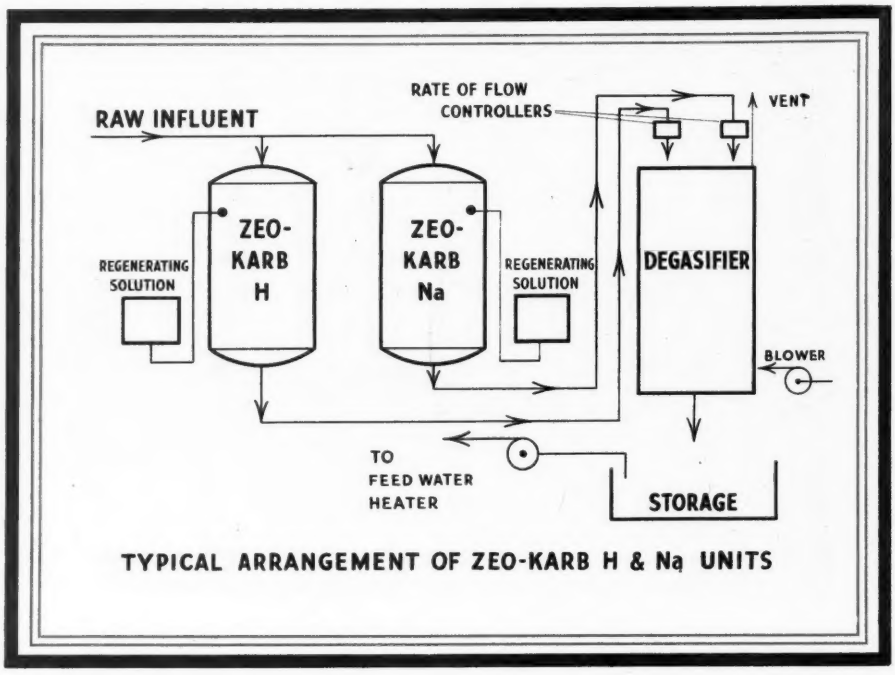
BY ION EXCHANGE ALONE

. . . . REDUCES TOTAL SOLIDS

. . . . . REDUCES ALKALINITY

READ DETAILS ON NEXT PAGE

HOW ZEO-KARB H REDUCES TOTAL SOLIDS CONTROLS ALKALINITY



TYPICAL ARRANGEMENT OF ZEO-KARB H & Na UNITS

Latest member of the Permutit family . . . worthy cousin to Permutit Hot Lime Soda and conventional zeolites is Zeo-Karb H, the new Permutit Zeolite that improves upon both hot lime soda and the heretofore available zeolites. It is made from carbonaceous material and is *non-siliceous* . . . the first zeolite to possess this characteristic.

Zeo-Karb H marks a revolutionary advance in the art of boiler feedwater treatment. It can be used with water of any hardness, and offers the important advantages of (1) removing scale-forming hardness while (2) simultaneously reducing total solids, and (3) reducing and controlling alkalinity to obtain ideal conditions for maintaining desired sulphate: carbonate ratios, all in positive fashion.

Zeo-Karb H is a hydrogen zeolite. By ion exchange, it gives up its hydrogen for calcium, magnesium and sodium in the raw water. Therefore, all bicarbonates in the raw water are converted to CO_2 which is mechanically scrubbed out by a simple degasifier. At the same time, chlorides and sulphates are converted to sodium chloride and sodium sulphate by blending with water which has passed through a sodium zeolite softener.

This new zeolite may also be operated through the sodium zeolite cycle, under which conditions it is called Zeo-Karb Na. It is very resistant to low pH and functions well on low hardness waters.

Thus, with a twin hydrogen and sodium Zeo-Karb unit installation, a blended effluent can be produced *by ion exchange alone* to yield boiler feedwater of low total solids and low alkalinity.

Write for complete information regarding this revolutionary new Permutit feedwater treatment! No obligation.

SEND FOR THE NEW ZEO-KARB BULLETIN

THE PERMUTIT COMPANY
330 West 42nd Street, New York City
Bulletin sent free on request.

Name .....
Company .....
Title .....
Address .....
City ..... State .....

Permutit
Water Conditioning

INCLUDES ALL METHODS · PROTECTS THE BOILER

Unusually Low Costs per ton for unloading to storage on these Outboard Rollers

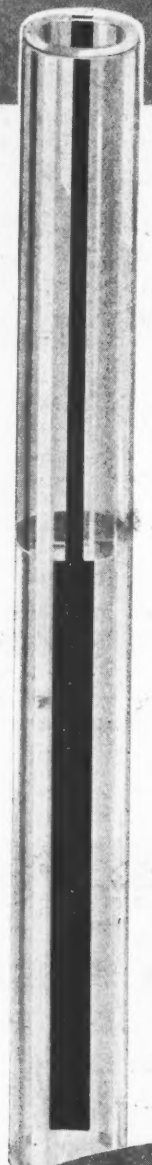
● The Outboard Roller on the Rex Leakproof Apron Pan Conveyor is one of the reasons why a well-known modern power plant using these conveyors secured coal costs of 1½c per ton . . . for direct labor . . . for unloading . . . 13.9c per 1000 pounds of steam generated. The complete Rex handling system is one of the reasons why this power plant operates 24 hours per day at 83% efficiency.

The Rex Outboard Roller eliminates eccentric chain loads—gives a rolling action on both runs—permits large diameter rollers for low friction—makes lubrication easier—and makes Rex Apron Feeder Chains *last twice as long.*

CHAIN BELT COMPANY
1677 West Bruce Street, Milwaukee, Wisconsin

Waiting to be sent to you is a new book "How to Handle IT," which shows some 40 examples of material handling in some 20 industries.

REX
CHAIN BELT COMPANY
OF MILWAUKEE
Chain and Belt Conveying



To help insure sustained safe flight under all conditions, more than 75% of airplanes in commercial service are fitted with two or more engines.

Reflecting SONDERGLASS, which hundreds of engineers think of as "The Unbreakable Gauge Glass," similarly brings a new degree of safety to boiler room operation by helping protect against water column blow-outs.

Reflecting SONDERGLASS is extra sturdy and extra safe because it is formed of two layers of glass made with semi-metallic substances with different degrees of expansion, thus producing what is virtually a double strength tube. The inside of the tube expands in proportion to the temperature of the steam or water, while the outside resists the shattering effect of sudden cold drafts.

The amazing strength and toughness of Reflecting SONDERGLASS has been repeatedly shown by dipping it in hot oil, 450 deg. F., then plunging it into cold water without breakage. It has also safely withstood pressures up to 1000 lb.

Decide now to stop gambling with men's eyesight. One poor fellow blinded or mutilated by flying fragments of glass may cost you a thousand times more than the slight expense of fitting every water column with Reflecting SONDERGLASS. Order from your nearest dealer. Do not accept a substitute!

A. W. CHESTERTON CO.,
64 India Street Boston, Mass.

SAFEGUARD EYESIGHT WITH
SONDERGLASS
"The Unbreakable Gauge Glass"

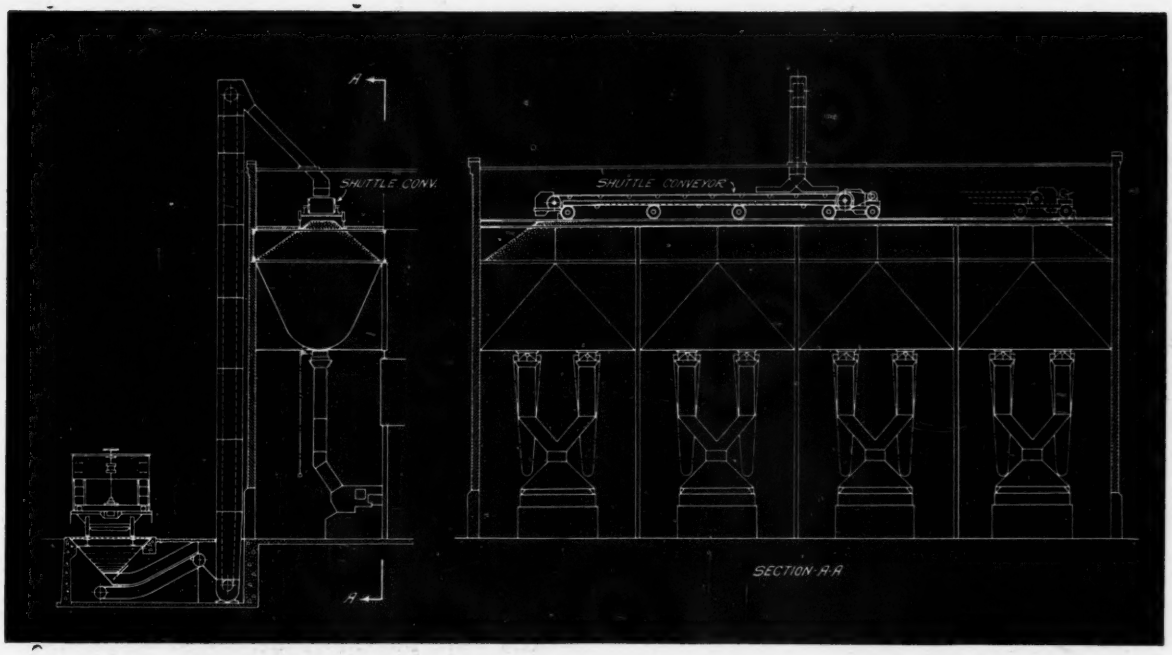
USERS say the increased speed with which Airetool Cleaners tackle scale reduces the "down time" of boilers and condensers as much as 50%.

The greater adaptability of each Airetool means a smaller equipment investment. And the rugged construction and long life of Airetools hold down replacement expense. Made in all sizes for water tube boilers, straight or curved tubes and straight tubes in return tubular boilers. Air, steam or water driven.

Write for latest descriptive Airetool bulletin.

THE AIRETOOL MFG. CO., 320 Center St., Springfield, Ohio.

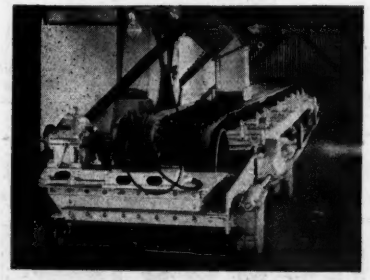
GOETZE
for
GASKETS
Research and engineering activities, painstaking, costly, have given Goetze engineers exact knowledge of many factors having to do with gaskets and the functions they perform. Avail yourself of this knowledge when you need gaskets *for any service.*
Goetze Gasket & Packing Co., Inc., 17 Allen Ave., New Brunswick, N. J.



LOWER HEADROOM

is only one of many advantages of ROBINS SHUTTLE CONVEYOR

The steady, quiet travel of the shuttle frame and the travel of the reversible Conveyor Belt mounted on this frame, automatically distribute the coal evenly throughout the entire length of your bunker. Economical? Yes. The Belt Conveyor costs less because it is shorter than a tripper line, only one motor is used and no tripper is required. The compact design permits its use in confined spaces such as between members of a roof truss or under a low roof. With the Robins Shuttle Conveyor you can enlarge your bunker capacity by bringing it nearer the roof. Lower power consumption and little or no maintenance cost makes this system a most economical and dependable method of filling your bunker.



The belt runs in one direction for filling half the length of the bunker and in the other direction to fill the second half.

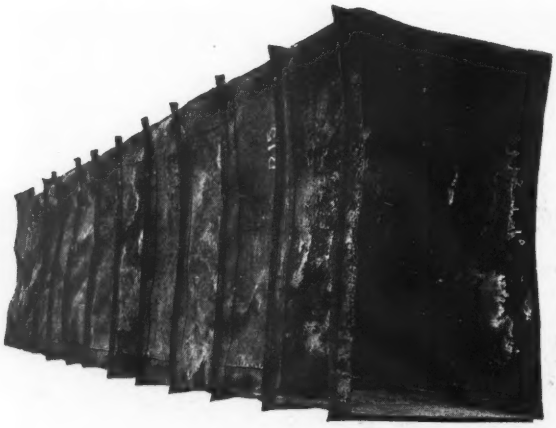
Robins Shuttle Conveyor is described on page 73 of bulletin 82 A. Other products have special pages and bulletins. Send for sheets of interest.

ROBINS MAKES:

Belt Conveyors
Pivoted Bucket Conveyors
Crushers Feeders
Weigh Larries
Skip Hoists Gates
Trippers

MATERIAL HANDLING ROBINS EQUIPMENT

ROBINS CONVEYING BELT CO., 15 Park Row, New York, N. Y.
Please have your representative call ( ).
Please send sheet describing.....
Name .....
Firm .....
Address .....
City ..... *State*.....



*Connery's Improved Accordian Type Expansion Stiffener construction is air and moisture tight, buckle and warp proof. Let us tell you more about it.

This can't happen with

CONNERY CONSTRUCTION*

The above section, 6 ft. wide, 15 ft. high, was part of six breechings removed from plant of one of the large oil companies after only six years' service. Note how inequality of heat on reinforcing members has buckled and warped this breeching. Connery Improved Expansion Stiffener type, welded joint, breechings are now doing satisfactory duty on this job.

CONNERY CONSTRUCTION COMPANY
4000 North Second Street **PHILADELPHIA, PA.**

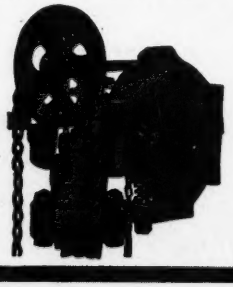
BAYER

BALANCED VALVE-IN-HEAD

provides a valve action independent of element rotation—supplies full steam pressure necessary for full efficiency in reaching and cleaning all heating surfaces in present-day boilers.

CHRONILLOY ELEMENTS

made of austenitic high-temperature alloy have demonstrated longer low cost service life for Bayer Soot Cleaners. Write today for descriptive Bulletin No. 107.



THE BAYER COMPANY
4065 Park Ave. St. Louis, Mo.

HENSZEY

FEED WATER METER

This meter operates within 2% of absolute accuracy regardless of heat or dirt in the water. It also measures the pulsating flow of a reciprocating pump.

Write for Literature

HENSZEY COMPANY
Dept. C 12 Watertown, Wis.

• NICHOLSON •

A REAL TRAP

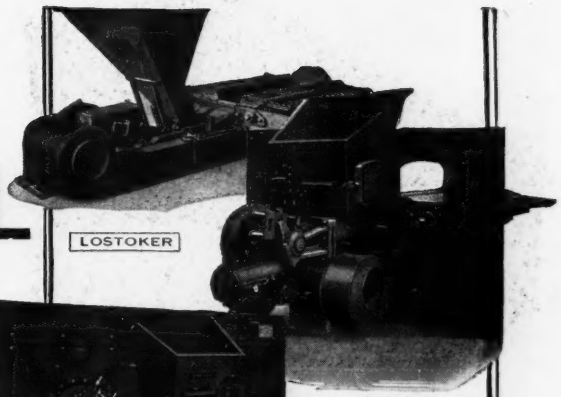
Cannot freeze (can be placed right out in the weather); is never water-logged; cannot air-bind; intermittent discharge; largest water and air discharging capacity of any trap on the market; same size valve is used on vacuum as at 200 lbs.; moderate in price. "Nicholson" Industrial Trap Bulletin No. 337 on request. Sent on trial.

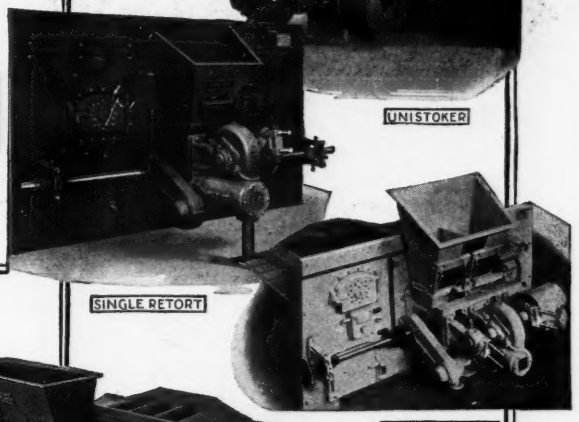
Other Products—Nicholson Piston and Weight Operated Traps, Flexible Couplings, Expanding Mandrels, Arbor Presses, Compression Shaft Couplings, Steam Eliminators and Separators, Compressed Air Traps, Steel and Stainless Steel Floats.

W. H. NICHOLSON & COMPANY
160 Oregon St. Wilkes-Barre, Pa.

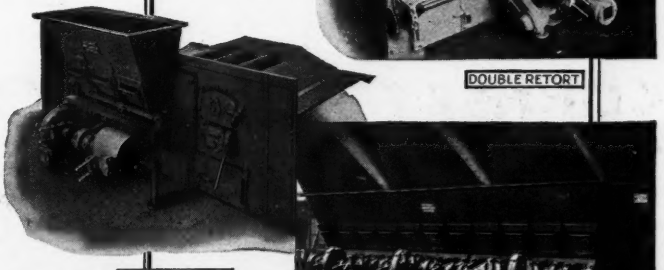
ECONOMICAL STEAM GENERATION IN

POWER PLANTS
FACTORIES
WAREHOUSES
HOTELS - HOSPITALS
SCHOOLS - CHURCHES
APARTMENTS
LAUNDRIES
GREENHOUSES
CREAMERIES
SERVICE STATIONS
STORES and OFFICES
PUBLIC BUILDINGS

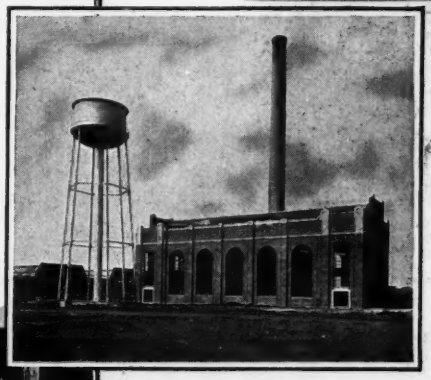

LOSTOKER


UNISTOKER

SINGLE RETORT


DOUBLE RETORT

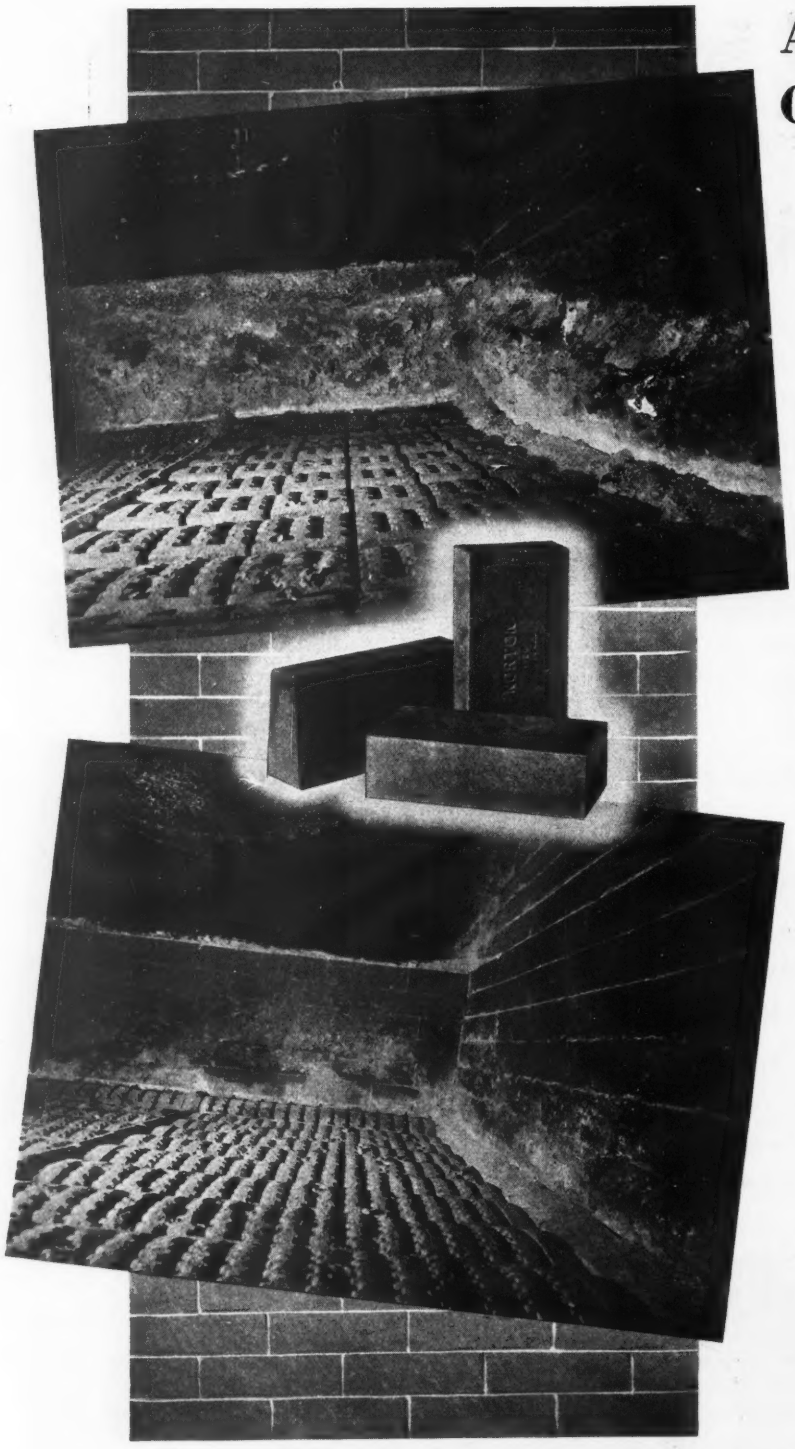
TRIPLE RETORT


MULTIPLE RETORT

DETROIT STOKER COMPANY
General Motors Building
DETROIT MICHIGAN
WORKS AT MONROE MICHIGAN
In Canada
DETROIT STOKER COMPANY OF CANADA, LIMITED
TORONTO WINDSOR MONTREAL

Write for Bulletin 524

DETROIT STOKERS



Another Comparison

That Shows the Value of CRYSTOLON BRICK

HERE are two more unretouched photographs that show the comparative condition of ordinary brick (above) and Crystolon Brick (below) in a pair of heating boilers.

The boiler lined with Crystolon Brick is still good for many years of trouble-free service — no danger of a "shut-down" during the heating season.

The firemen are enthusiastic about Crystolon Brick. Clinkers come loose easily with a touch of the bar — and they don't take a whole section of wall with them.

It will pay *you* to use Crystolon Brick.

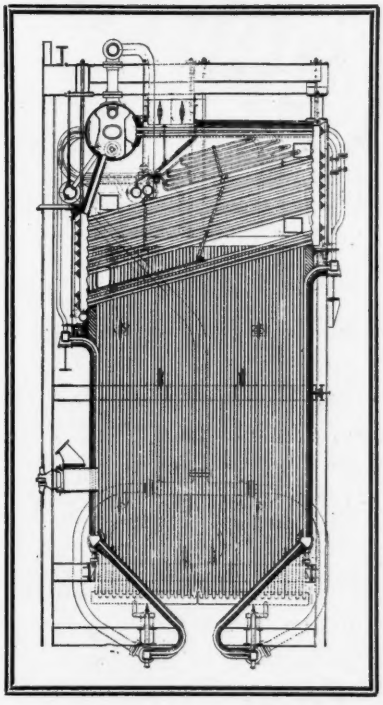
NORTON COMPANY
Worcester, Mass.
New York **Chicago**
Cleveland

R-582

SPRINGFIELD BOILERS & WATER WALLS

SECTIONAL —— ALL STEEL

Distinguished by Repeat Orders



One of Four 150,000 lb. Units, 506 lb. Pressure, Installed for Anheuser-Busch, Inc., St. Louis, Mo.

In The Industrial Field

Standard Oil Co.
9 Orders—17 Units for 5 Plants

International Harvester Co.
6 Orders—8 Units for 6 Plants

American Metal Co.
4 Orders—8 Units for 2 Plants

Deere & Company
10 Orders—12 Units for 6 Plants

Brown & Williamson Tobacco Co.
5 Orders—6 Units for 3 Plants

SPRINGFIELD BOILERS ARE BUILT IN ALL SIZES AND FOR ALL PRESSURES

Our Engineers will be glad to give you the benefit of their many years' experience in the designing of complete steam generating equipment.

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REPEAT ORDERS CONSTITUTE THE LARGEST PART OF OUR BUSINESS

SPRINGFIELD BOILER CO.

SPRINGFIELD, ILLINOIS

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New York
Philadelphia
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SPRINGFIELD BOILERS

OFFICES

Oswego
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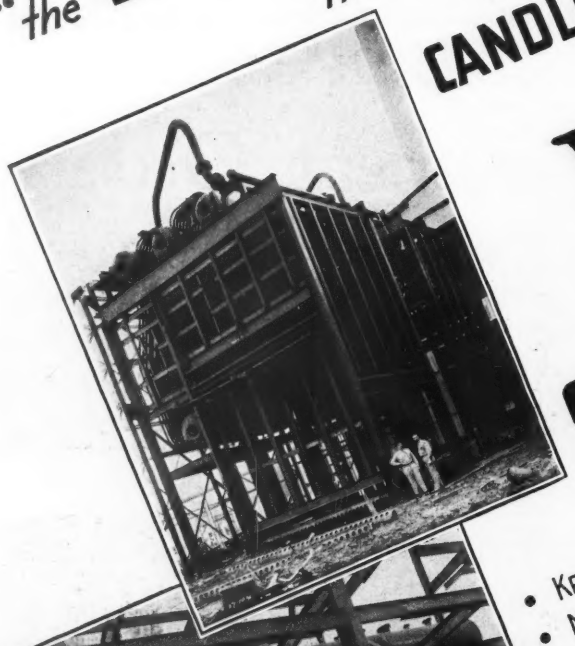
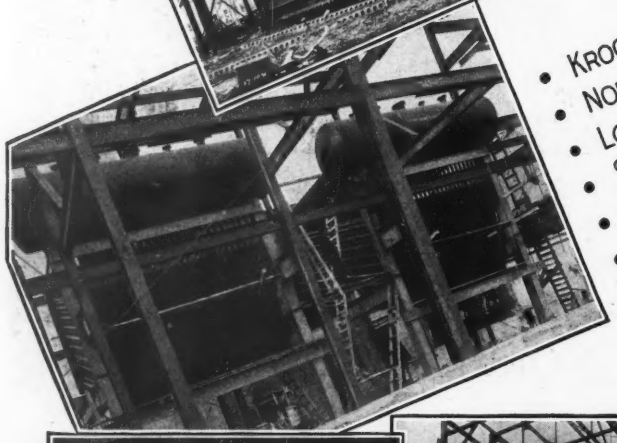
"the BUTCHER— the BAKER— the CANDLE-STICK MAKER" come to

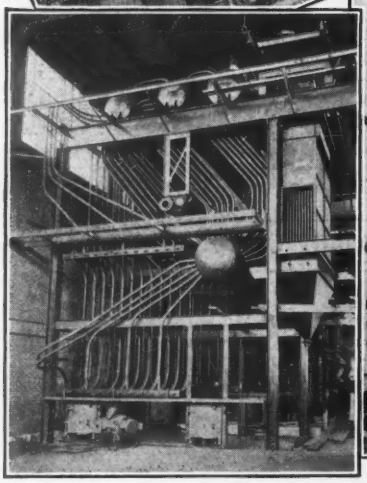
Vogt for STEAM BOILERS

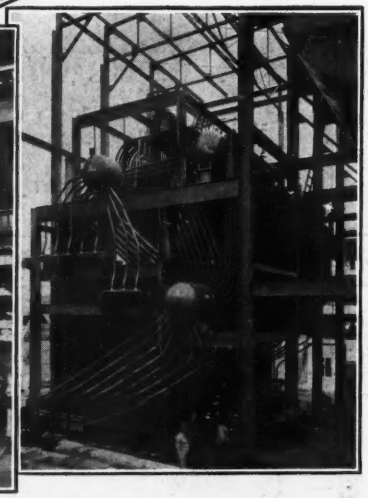




Typical Installations:

- KROGER GROCERY & BAKING CO., Cincinnati, O.
- NORTHERN STATES POWER CO., Minot, N. D.
- LOOSE-WILES BISCUIT CO., Kansas City, Mo.
- ST. LOUIS DAIRY CO., St Louis, Mo.
- KRAFT-PHENIX CHEESE CO., Antigo, Wis.
- SHELL PETROLEUM CO., Houston, Tex.
- KIMBLE GLASS CO., Vineland, N. J.





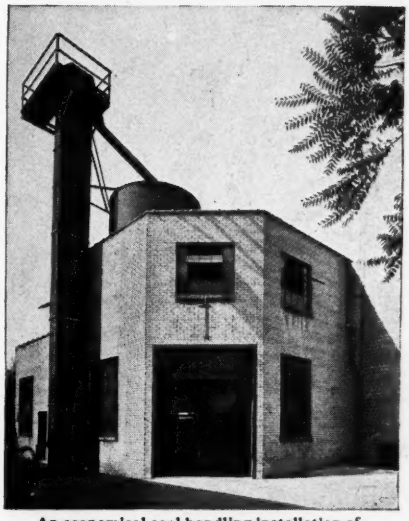
BENT TUBE SECTIONAL HEADER AND BOX HEADER TYPE BOILERS *for any fuel*

BRANCH OFFICES:

NEW YORK
PHILADELPHIA
CLEVELAND
CHICAGO
KANSAS CITY
DALLAS

HENRY VOGT MACHINE CO., Inc., LOUISVILLE, KY.

Wherever Coal is Burned



An economical coal handling installation of moderate size, for storage and handling to stoker hoppers.

● Consulting engineers and operators of large and small power plants, in every section of the country, have long known through actual experience that Link-Belt mechanical handling, crushing, screening and power transmitting equipment are durable, dependable, and economical, being built to last, and to operate at maximum efficiency. Send for General Catalog No. 700.

Link-Belt Company, Chicago, Philadelphia, Indianapolis, Atlanta, San Francisco, Toronto, or any of our other offices located in principal cities.

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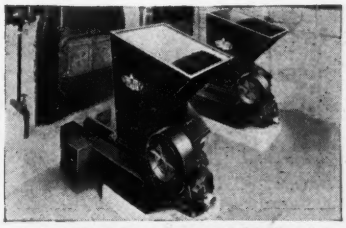
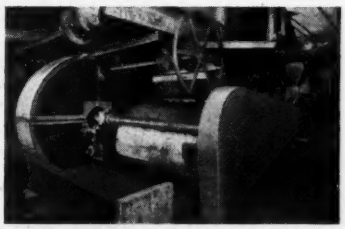
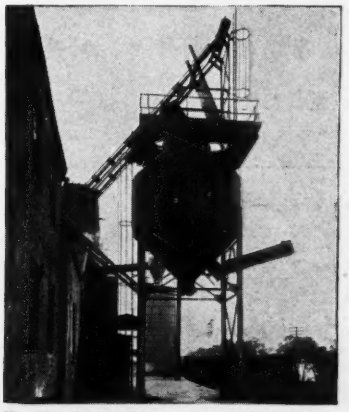


Automatic stokers, commercial, industrial and residential types, for boiler capacities up to 300 B.H.P.

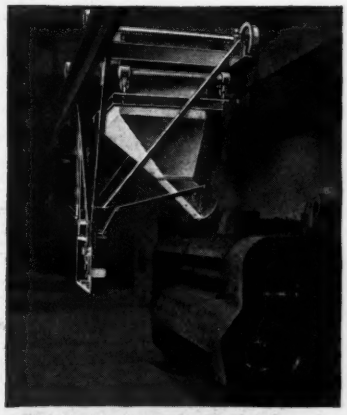


A complete line of single and double roll coal crushers.

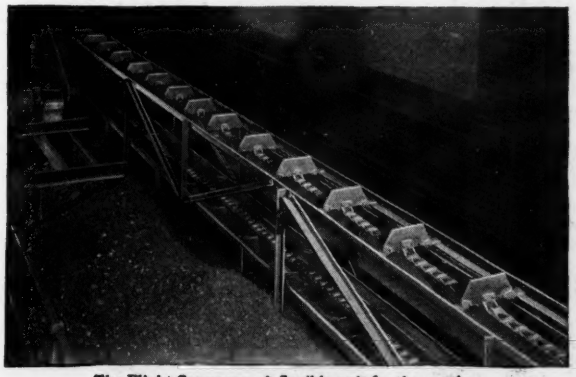
For handling coal in the power plant the belt conveyor is a reliable, flexible unit of large capacity and economy.



The Skip Hoist offers economy in installation and upkeep, for handling either coal or ashes, under conditions where it is best adapted.



Weighing and recording coal delivered, is a check on plant efficiency — use Link-Belt Traveling Weigh Larry.



The Flight Conveyor. A flexible unit for the gentle handling and discharging of coal.

The Peck Carrier Overlapping Pivoted Bucket Carrier. The one machine handles both coal and ashes.

LINK-BELT *Coal and Ashes* CONVEYORS

F&E Stokers

Nearly ¼ century of experience in combustion engineering and stoker building stands behind every "F & E" Underfeed Stoker. To date over 6,000,000 boiler horsepower is equipped with "F & E." ★ Check these outstanding features:

Interval Timer Governor (patented)
Foolproof against breakdowns
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Fuel bed control
Zoned air distribution

Only "F & E" Underfeed Stokers have the patented Interval Timer Governor which assures the perfect regulation of coal feed that is so vital in the efficient operation of an underfeed stoker.

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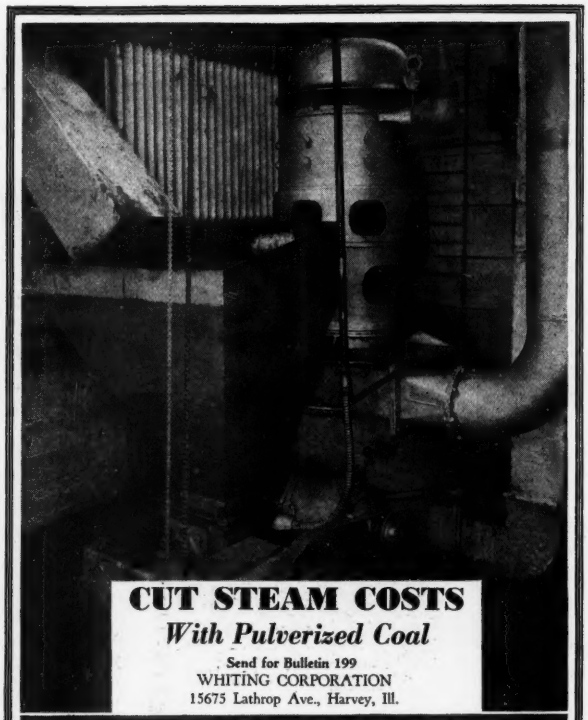

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THE ORIGINAL MULTIPLE RETORT UNDERFEED STOKER

The Taylor Stoker consists of a supporting structure, coal feeding and distributing rams and devices for distributing the air and discharging the ashes. These component parts can be combined in many ways to form a coal burning unit from 200 H.P. up to central station capacities to meet individual requirements . . . The Taylor Stoker is the basis of the highly perfected, dependable, Taylor Unit System of Combustion, including A-E-CO Water Cooled Walls, preheated air, A-E-CO Metered Air Control and A-E-CO Ash Hoppers or Hydraulic Ash Sluice . . . Taylor Stokers are used in modern central stations, municipal and industrial plants, universities and institutions and are backed by an engineering organization internationally recognized.

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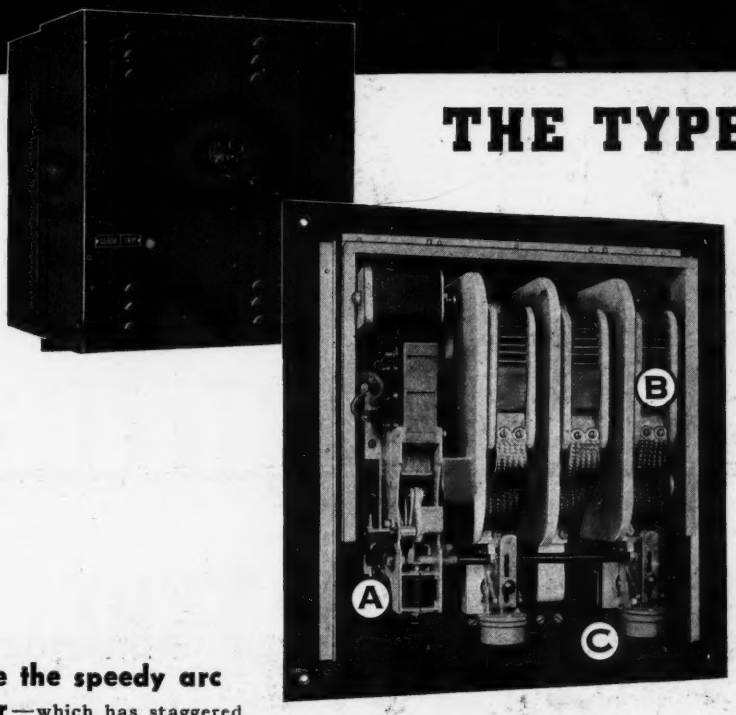
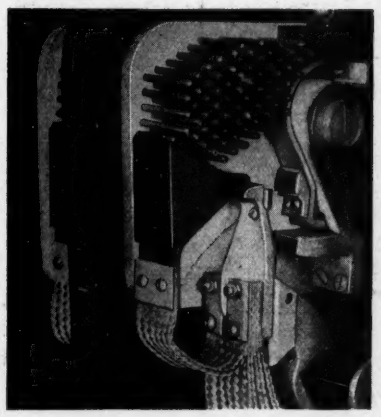
Everybody's Talking about This New G-E Air Circuit Breaker

THE TYPE AE-1

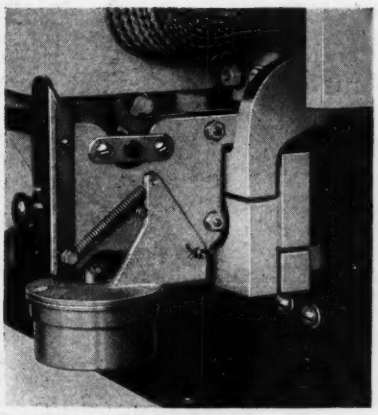


Operating mechanism (A), arc quencher (B), and dual overcurrent trip (C)

They like the speedy arc quencher—which has staggered pins that break up the arc for quick extinction and cooling. This remarkable quencher snuffs out arcs in one cycle or less.



—and the dual overcurrent trip—which discriminates between a harmless overload and one which would be injurious to equipment or personnel. It is, in fact, one mechanism that performs two functions. One provides time-delay tripping for normal overloads; and the other, instantaneous tripping for dangerous overloads above ten times normal.



You can mount this breaker in several convenient ways:

—Enclosed with pull box on a wall
—Enclosed on a panel
—On live-front switchboard
—On dead-front switchboard

Try it and you will swear by it. Available for 600 volts a-c, 250 volts d-c, 15 to 600 amp, 20,000 amp interrupting rating. ELECTRICALLY OR MANUALLY OPERATED. Bulletin GEA-2450. General Electric Company, Schenectady, N. Y.

GENERAL ELECTRIC

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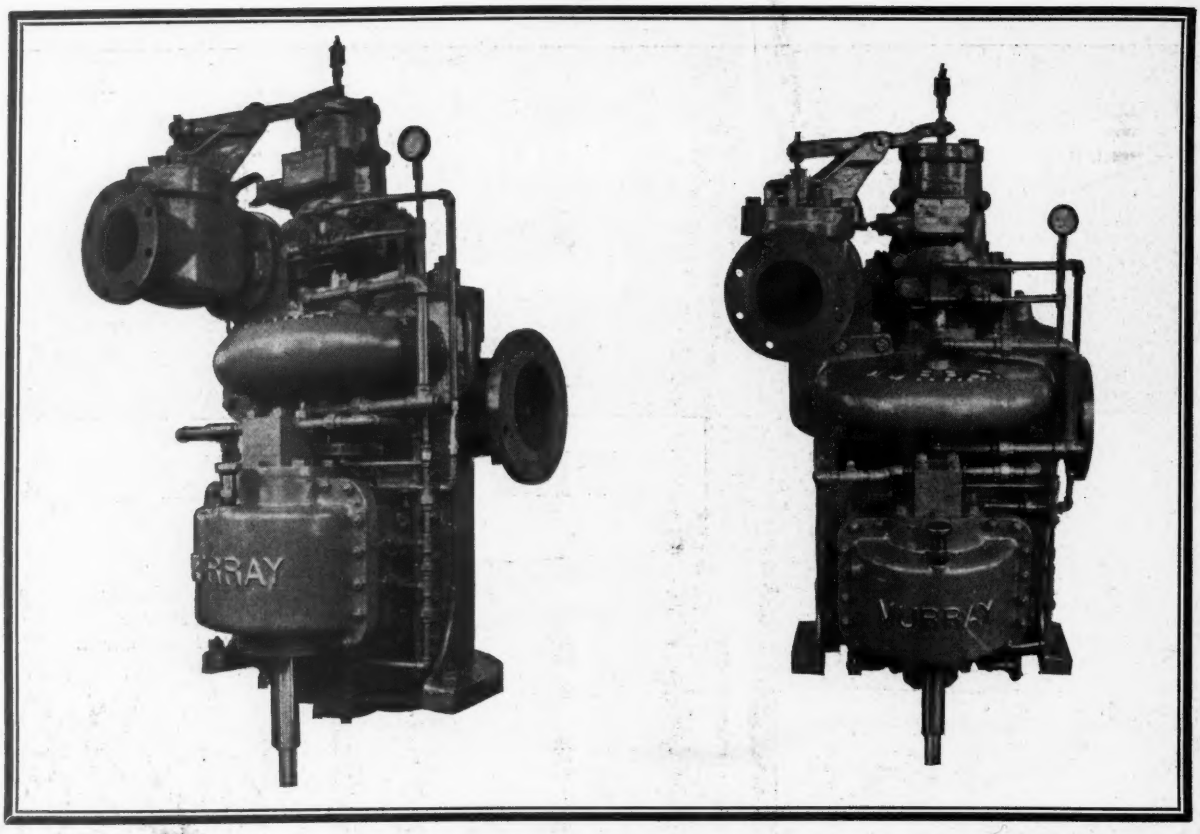

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Designed for Deep Well Pump Drives

Other Murray Products:

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CORLISS AND FOUR-VALVE ENGINES

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TURBINE UNIT HEATERS

These units can be furnished for direct connection or through reduction gears. Built for any operating steam pressure. Built to meet horsepower and speed conditions required.

Turbines are provided with constant speed and emergency governors operating independent valves. Bearings and reduction gear are lubricated by MURRAY forced feed oiling system.

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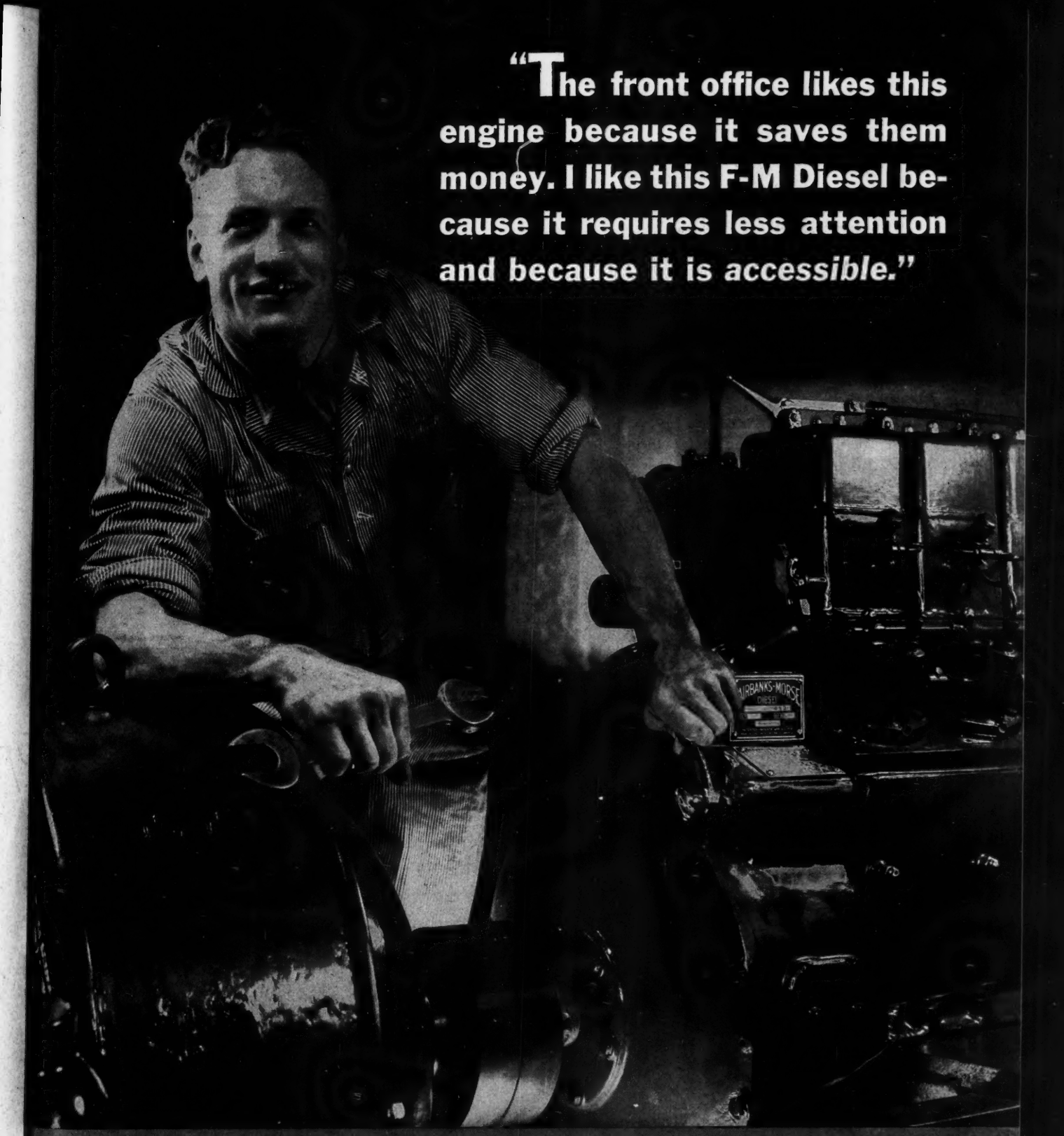
"The front office likes this engine because it saves them money. I like this F-M Diesel because it requires less attention and because it is *accessible.*"
FAIRBANKS-MORSE
DIESEL

FAIRBANKS MORSE Diesels

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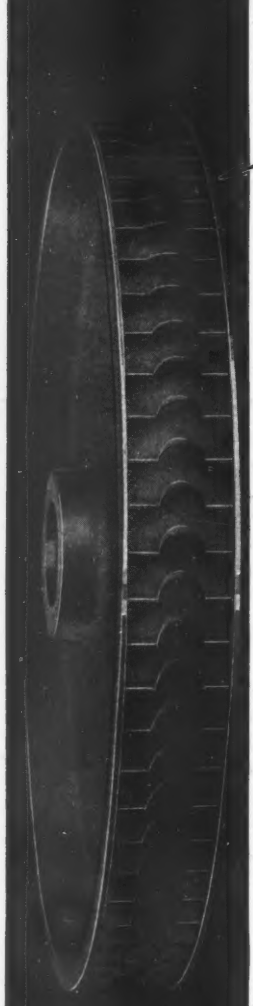
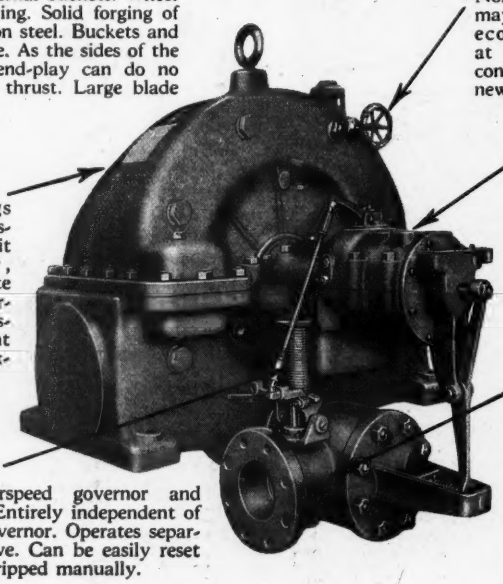


Indestructible internal buckets. Wheel rim prevents fouling. Solid forging of special composition steel. Buckets and wheel in one piece. As the sides of the wheel are free, end-play can do no damage. No end thrust. Large blade clearance.

Casing, bearings and governor housing are all split horizontally, allowing complete dismantling of turbine without disturbing alignment or steam and exhaust piping.



Independent overspeed governor and overspeed valve. Entirely independent of constant speed governor. Operates separate overspeed valve. Can be easily reset and can also be tripped manually.

Nozzle control valves may be provided for economical operation at partial load. Nozzle control valves have renewable seats and discs.

Completely enclosed governor and self-closing bearing inspection caps prevent dirt or dust from interfering with turbine operation. Heavy cast governor housing.

Double-seated balanced governor valve with renewable seats. Valve rigidly supported direct on turbine casing is located low down to withstand pipe strains without causing misalignment.

ALL THESE ADVANTAGES AND MANY MORE IN THE TERRY WHEEL TURBINE

● **The Terry Solid Wheel Turbine with its durable rotor construction and its many other noteworthy design features is ideally equipped to handle all mechanical drive applications.**

● **It is fully described in our bulletin S-116. A request on your business letterhead will bring a copy.**

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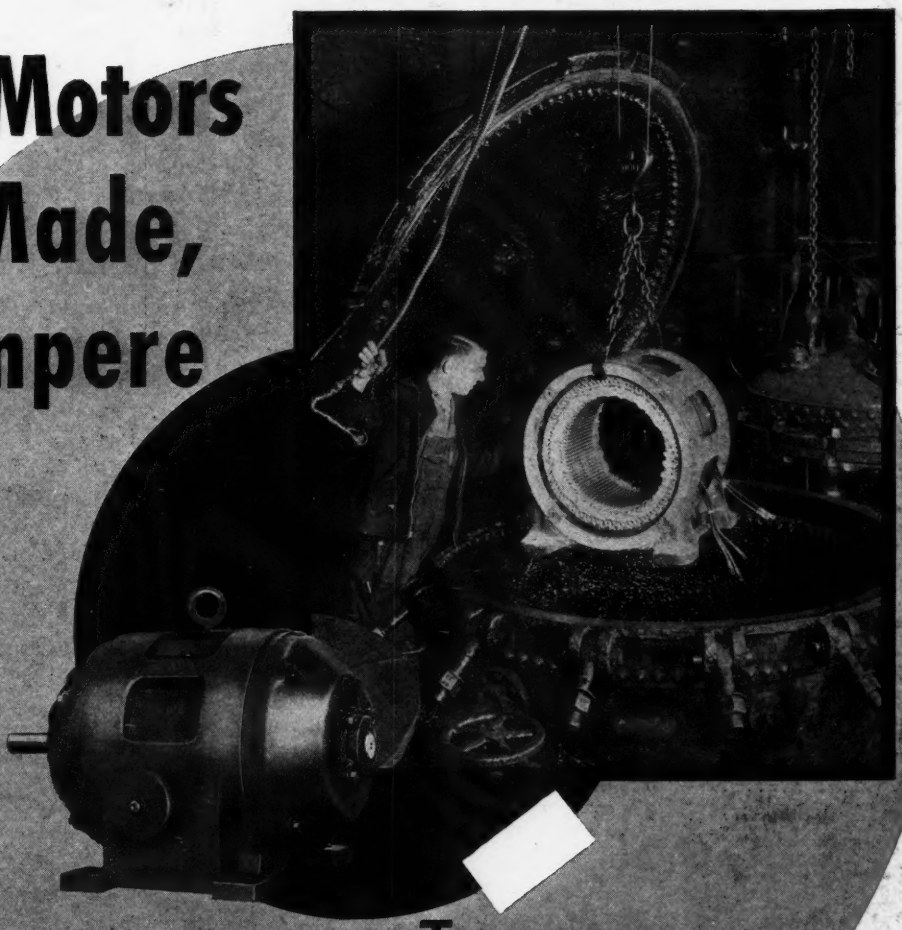
THE TERRY STEAM TURBINE COMPANY

TERRY SQUARE, HARTFORD, CONN.

How Motors are Made, at Ampere



The illustration shows an induction motor stator about to have its life line lengthened—by means of the vacuum impregnation process.

The stator is placed in a vacuum tank under a high vacuum to remove the last traces of moisture, and is then subjected (under heavy pressure and high heat) to impregnation with insulating varnish. The varnish penetrates to every part of the windings, filling any air pockets that may have been present, and making the windings dirt, oil and moisture resisting to the highest possible degree.

This process is not used generally in the making of motors because it is an expensive process requiring very expensive equipment. It is used at Ampere—that is the reason Crocker-Wheeler motors last so long on the job.

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ALPHABETICAL INDEX TO ADVERTISERS

Airetool Mfg. Co., The.....140
Allis-Chalmers Mfg. Co.....31, 130
American Blower Corp. 32
American Chain & Cable Co., Inc.....119
American Coal Burner Co.....148
American Engineering Co.....148
American Hammered Piston Ring Division of Koppers Co...127-128
American-Marsh Pumps, Inc.....129
Armstrong Machine Works..... 8

Babbitt Steam Specialty Co.....122
Babcock & Wilcox Co., The...10-11
Bailey Meter Co. 22
Bartlett-Hayward Division of Koppers Co. 127-128
Bayer Co., The.....142
Biddle Co., Jas. G.....129
Brassert & Co., H. A.....126
Brown Instrument Co., The.....136
Buromin Co., ... 33

Cash Co., A. W..... 30
Chain Belt Co. 139
Chaplin-Fulton Mfg. Co., The...132
Chapman Valve Mfg. Co., The.. .....Inside Back Cover
Chesterton Co., A. W.....132, 140
Cochrane Corp. 24
Combustion Engrg. Co., Inc..... 4-5
Connery Const. Co. 142
Corning Glass Works..... 26
Crane Co. 113
Crocker-Wheeler Elec. Mfg. Co..153

Dart Mfg. Co., E. M.....116
De Laval Steam Turbine Co.122, 133
Detroit Stoker Co.....143

Edward Valve & Mfg. Co., The..105
Elgin Softener Corp. 136
Elliott Co. 3
Engineering and Construction Division of Koppers Co...127-128

Fairbanks Co., The.....120
Fairbanks, Morse & Co.....151
Flynn & Emrich Co.....148
Foster Wheeler Corp..... 34
Foxboro Co., The.....132

Garlock Packing Co. 12
Gas and Coke Division of Koppers Co.....127-128
General Electric Co. 17, 109, 149
Goetze Gasket & Pkg. Co. 140
Golden-Anderson Valve Spec. Co. 116
Graver Tank & Mfg. Co., Inc....110
Grinnell Co., Inc..... 25
Gulf Oil Corporation.....6-7
Gulf Refining Co.....6-7

Hagan Corp. 33
Hall Laboratories 33
Hays Corp., The..... 27
Henszey Company 142
Hercules Float Works.....126
Huyette Co., Inc., The Paul B....126

International Nickel Co., The....124

Jenkins Bros. 111
Johns Manville 23, 121, 134

Keasbey & Mattison Co..... 29
Kennedy Valve Mfg. Co., The...123
Koppers Co. 127-128
Koppers Coal Co. 127-128
Koppers Rheolaveur Co. 127-128

Link Belt Co. 147
Lunkenheimer Co., The.....115

Manzel Bros. Co.....136
Midwest Piping & Supply Co., Inc. 13
Minneapolis-Honeywell Regulator Company 136
Moore Steam Turbine Corp. ....Back Cover
Morehead Mfg. Co..... 21
Mueller Brass Co. 114
Murray Iron Wks. Co. 150

National Aluminate Corp.....107
Nicholson & Co., W. H. 142
Northern Equipment Co. 14
Norton Co. 144

Permutit Co., The 137-138
Philadelphia Gear Works..... 15
Pierce Co., The Wm. B.....136
Powell Co., The Wm. 125

Reading-Pratt & Cady Div. 119
Reliance Gauge Column Co., The. 16
Republic Flow Meters Co. 18
Robins Conveying Belt Co.....141
Roto Co., The.....126

Sarco Co., Inc.....117-118
Scaife & Sons, Wm. B.....126
Signboard Section 110
Smooth-On Mfg. Co.....129
Snap-On Tools, Inc. 123
Socony-Vacuum Oil Co., Inc...19-20
Springfield Boiler Co.....145
Squires Co., The C. E. 136
Standard Oil Co. (Indiana)..... .....Inside Front Cover
Streamline Pipe & Fittings Div...114
Strong, Carlisle & Hammond Co. 122-136
Sturtevant Co., B. F..... 35

Terry Steam Turbine Co., The...152
Texas Co., The..... 28
Timken Roller Bearing Co., The..131

Vogt Machine Co., Henry.....146

Warren Steam Pump Co. 135
Western Division of Koppers Co. 127-128
Whiting Corp. 148
Wickes Boiler Co., The.....148
Williams Valve Co., The D. T...122
Wood Preserving Corp., The.127-128

Yarnall-Waring Co. 9, 36